JUL 31 1922

MECHANICAL ENGINEERING

INCLUDING THE ENGINEERING INDEX

ARCHIMEDES, M.E.
(Class of 266 B.C.)

"These machines he (Archimedes) had designed and contrived, not as matters of any importance, but as mere amusements in geometry; in compliance with King Hiero's desire and request that he should reduce to practice some part of his speculation in Science, and by accommodating the theoretic truth to sensation and ordinary use, bring it more within the appreciation of the people in general.
. . . So it was that mechanics came to be separated from geometry, and repudiated and neglected by philosophers."

PLUTARCH

AUGUST 1922

THE MONTHLY JOURNAL PUBLISHED BY THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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Contributors and Contributions

Material-Handling Equipment as Used in the Iron and Steel Industry

F. L. Leach describes the heavy machinery used in handling steel from the time the ore leaves the mines until it goes through the last process at the mill. Mr. Leach was employed in the capacity of estimating engineer with Perin & Marshall of New York City for three years. Previous to this he was with the Upson Bolt & Nut Co. of Cleveland as assistant chief engineer for six years, and the East Ohio Gas Co. of Cleveland. Mr. Leach has had experience in blast-furnace design and construction, power-house and rolling-mill design and construction, locomotive-crane design, powdered-coal-fuel equipment, concrete dock construction, and railway and steam transportation systems. In January of this year he sailed for India where he has since been assistant works manager for the Agricultural Implements Co., Ltd., of Bombay, at their plant in Jamshedpur.

Centrifugal Castings

Although the fundamental principles involved in the production of castings by pouring the molten metal into a revolving mold are not new, understanding of the possibilities of this process has not been general. The article on this subject relates something of the development of the art and discusses some of the problems of design and operation of casting machines. The field of application of centrifugal castings is also treated. Leon Cammen, the author, is Associate Editor of MECHANICAL ENGINEERING. He has taken out a number of patents relating to centrifugal castings, the most important involving a heated mold.

Hydroelectric Power-Plant Design

J. A. Sirnit discusses the details of construction and equipment of hydroelectric power plants which will give best results in maintaining full capacity of the plants during flood periods. Mr. Sirnit was born in Russia and received his education at the Technical School, Mittweida, Germany, from which he has degrees in electrical and mechanical engineering. His first experience after receiving his degrees was with the Allgemeine Electrical Co. at Riga, Russia, where he became assistant superintendent of shops in charge of production. He came to America in 1907 and for five years was with the Westinghouse Electric & Manufacturing Co. at East Pittsburgh, Pa. Here he did drafting and designing of switchboards, power-plant and sub-station layouts. Later he was in charge of all designs on projects and preparing plans for switchboards, power-plant and sub-station layouts. Since 1912 Mr. Sirnit has been designing and electrical engineer for the Alabama Power Co. at Birmingham. In this capacity he has designed their 90,000-hp. hydroelectric plant at Lock 12, Coosa River, the 6000-kva. sub-station at Jackson Shoals and the 25,000-kva. steam-electric plant at Warrior River.

Boiler House of the American Sugar Refining Co. at Baltimore, Md.

A new type of installation for burning small hard coal is described in this paper by E. B. Powell. This plant was installed by Stone & Webster, for whom Mr. Powell is at present consulting engineer. He received his early training with the Electro-Chemical Storage Battery Co. and the New York Heat, Light & Power Co. In 1899 he entered the employ of the New York Edison Co. and from 1904–1907 was in charge of their mechanical-testing laboratory. Since 1907 he has been with the Stone & Webster Engineering Corporation at Boston.

The Utilization of Waste Heat

A series of three papers appears in this issue which discuss the development of methods of utilizing waste heat, especially in the steel and cement industries. H. B. Smith, for the past ten years employed in the engineering department of Babcock & Wilcox, New York City, writes on Waste-Heat Boilers. Mr. Smith received the degree of B.S. from the University of Maine, and since that time has specialized on the design and operation of waste-heat installations in connection with his work with Babcock & Wilcox.

A. T. Lewis, who has been with the Bethlehem Steel Co. since 1909, discusses the Utilization of Heat in the Steel Industry. After experience in mechanical and experimental work with this company, Mr. Lewis spent two years in steel-rolling-mill operation. For the past three years he has been combustion engineer, specializing principally on combustion problems.

The third paper in the group, Utilization of Waste from Rotary Cement Kilns, is by Joseph Brobston. Mr. Brobston has been for the past twenty years the general manager in active charge of the operation of the plant of the Dexter Portland Cement Co. at Nazareth, Pa. During that time he has taken part in the work of the technical committees of the Portland Cement Association and has been chairman of the Conservation Committee practically since its formation. The material in the paper here presented has been taken largely from reports gathered by this Committee.

Paint Protection for Wood

C. T. Myers makes a plea for the protection of wood by paint, and for proper precautionary measures to be taken against moisture. Recent researches in the subject brought the necessity for paint protection to his attention. Mr. Myers was graduated from Stevens Institute of Technology in 1900 with an M.E. degree. Since that time he has done drafting and engine testing for the American Engine Co., and was assistant chief draftsman for the Rand Drill Co. and the International Steam Pump Co. of Pittsburgh. For four years he was assistant secretary and treasurer of the Wisconsin Engine Co., doing engineering, sales and executive work in all departments. Later he was with the General Motors Co. in charge of the organization of the mechanical-engineering department and of the design and construction of the motor-truck division. Mr. Myers is at present a consulting engineer at Rahway, N. J.

A.S.M.E. NEWS FILLS IMPORTANT PLACE

Although only recently completing its first six months of existence, the A.S.M.E. NEWS is already firmly established as an important factor in developing A.S.M.E. activity. It comes twice a month to the members of the Society with news of important events and it furnishes an easy means of contact between the members and the officers.

MECHANICAL ENGINEERING

Volume 44 August, 1922 Number 8

Material-Handling Equipment as Used in the Iron and Steel Industry

By F. L. LEACH,[1] JAMSHEDPUR, INDIA

This paper describes the handling machinery and apparatus used in the manufacture of steel. From the time that the ore leaves the mines until the steel goes through the last process at the mill it is moved about exclusively by different types of heavy machinery designed especially for the purpose. The author expresses the hope that through his description, weak points in present-day practice will show themselves and means of improvement be suggested.

THE iron and steel industry probably requires a greater diversity of material-handling equipment than any other type of manufacturing, because of the enormous bulk and weight to be handled. From the time the material leaves the mines until it is turned out of the mills as finished product it is constantly being moved by heavy conveying machinery of all descriptions. It is the intention of the author to describe this equipment with the idea of bringing out weak points in present-day practice, and possibly open the way to strengthen the weakest links in the conveying methods used.

As the principal object of this paper is to describe the machinery used about the industrial plant, just a brief description will be given of the handling methods before the material reaches the plant.

At the present time ore handling on the Great Lakes is carried on by a fleet of vessels unequaled anywhere in the world. Some of these vessels are capable of handling a cargo of 15,000 tons, and are over 600 ft. long. During the year 1916, 66,658,466 tons of ore were carried by the vessels from the upper Great Lakes to southeastern ports.

Vessels equipped for self-unloading have been developed for handling stone and ore. The hold in such cases is divided into bins, which deliver the material by gravity to a belt conveyor running lengthwise of the vessel; this conveyor delivers the material to an elevator which hoists it to another belt conveyor suspended in a horizontal position from the masts of the vessel and capable of being moved radially and vertically like the boom of a derrick. This belt conveyor delivers to the storage pile on the dock, and it is possible to distribute the material on the dock at any point or height desired within the scope of the boom conveyor.

Ore-unloading equipment has probably been developed to the highest point of efficiency at the ports on the Great Lakes. An example of this is Ashtabula harbor on Lake Erie, where there are eight Hulett ore unloaders having a capacity of 15 tons each. They have a record of unloading seven boats of a total capacity of 70,000 tons in 22 hours' actual time. Four 17-ton-capacity machines of this type have unloaded a cargo of 13,000 tons in 3 hours and 25 minutes. Fig. 1 shows a view of these machines in operation.

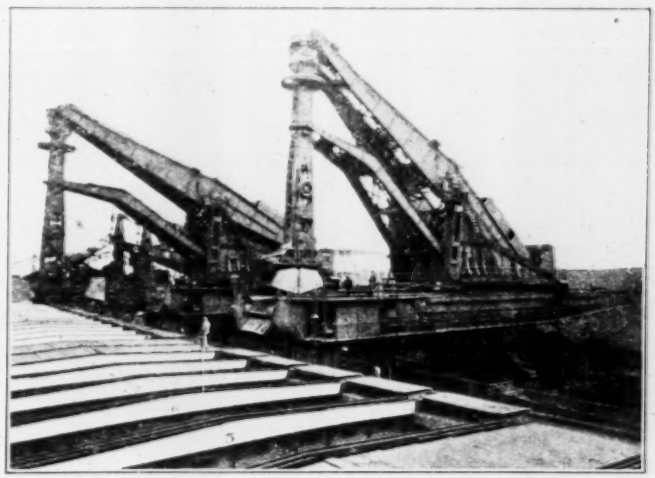

FIG. 1 HULETT ORE UNLOADER AT ASHTABULA HARBOR

These unloading machines remove the ore from the boat and dump it directly into railroad cars for shipment to inland plants, or they place it in a bin located at the rear of the machine where it may be picked up by a traveling ore bridge and placed in storage piles.

Ore shipped to inland plants in bottom-dumping cars may be unloaded directly into bins by gravity. However, the modern method is to use a traveling rotary car dumper as shown in Fig. 2, which can be spotted at any point in the length of the ore yard. The cars of ore are placed one at a time on the dumper, turned upside down and the ore dumped into a concrete pocket that extends the full length of the ore yard. An ore bridge similar to the one shown in Fig. 3 distributes the ore to the storage pile in the yard. Rotary car dumpers have been developed so that three men can unload about 20 cars per hour. Cars of 240,000 lb. capacity have been designed with a total dead weight of 78,800 lb., giving a ratio of revenue load to total weight of 75.4 per cent.

The traveling ore bridge is another valuable link in material-handling equipment and is used in many different ways in handling the ore at unloading docks. One of the largest bridges of this type ever built is 612 ft. long overall, and is used at the Western Pennsylvania Dock Company at Cleveland, Ohio. This bridge handles a 15-ton bucket and covers an ore storage of over a million tons.

Fig. 3 shows how these bridges may also be used to place the ore and limestone in bins, preparatory to sending them to the blast furnace. Several different types of bins are used, although the principle is the same in each. The ore is placed in the bin, either by the ore bridge or by gondola-type hopper cars, and it passes down through the bin by gravity as required, through a shut-off gate into a lorry car. From the bins an electrically driven weighing lorry car is used to convey ore, limestone and coke to the blast-furnace skip hoist.

Fig. 3 shows how material is conveyed from the stock yard and bins to the top of the blast furnace, dumped into the bell hopper by the skip car, and finally deposited inside by the well-known double bell system. Two of the products of the blast furnace are pig iron and slag, which are drawn off at the base in a molten state. Both iron and slag were formerly allowed to run from the furnace into sand molds and handled after cooling. Most plants today, however, run the molten iron and slag directly into ladles supported on special cars. In this way the iron is transported either to a pig-casting machine where it is cast into pigs, or to a mixer at the open-hearth plant where it is kept in the molten state, or further refined before it is placed in the bessemer converter for

[1] Asst. Wks. Mgr., Agricultural Implements Co., Ltd. Assoc-Mem. Am. Soc.M.E.

Abstract of a paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

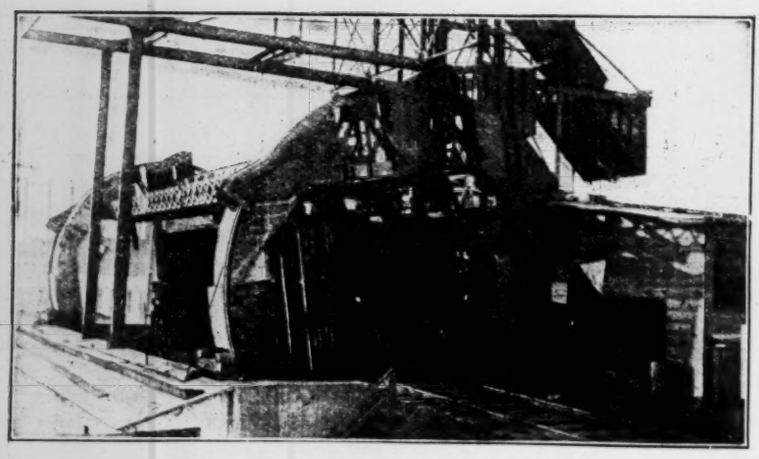

Fig. 2 View of Rotary Car Dumper

the duplex process. The molten pig iron may also be conveyed direct to the open-hearth furnace for the straight open-hearth process.

The slag is disposed of in various ways, since it has become of considerable commercial value in the last few years. After having been allowed to cool it is crushed to various sizes and then used in the place of crushed stone.

A new design of car known as the Pugh mixer-type hot-metal car, shown in Fig. 4, has recently been developed for handling hot metal from the blast furnace. This car, built in capacities ranging from 70 to 150 tons, is claimed to have many advantages over the ordinary type, chief among which are the heat-saving feature, which allows the hot metal to stand in the car for a period of 36 hours without "freezing." It is also a labor saver because, due to its large capacity, it requires fewer runners to distribute the metal from the furnace to the cars, thereby eliminating considerable scrap.

Fig. 5 shows a view of a typical slag car for conveying the molten slag away from the blast furnace. It is dumped pneumatically.

The Duplex System for Making Steel

Fig. 6 shows the plan of a modern duplexing system for manufacturing steel. The machinery in this department of steel making must stand the most severe treatment of all, as the steel is handled at temperatures ranging as high as 2900 deg. fahr. It can therefore readily be understood how important it is to have such machinery and equipment designed as perfectly and as safely as possible.

The hot metal from the blast furnace is brought to the mixers by ladle cars. In Fig. 6 this car is shown in position before a 1300-ton capacity mixer into which the content is poured by lifting the ladle free from the car with the aid of a 100-ton ladle crane.

The hot metal is removed from the mixer as required by tipping it so that metal will run out of a spout opposite the receiving side. Another ladle supported on a ladle car is used to transfer the hot metal from the mixer to the bessemer converter. This ladle is tilted by a jib crane and the contents poured into the top of the converter already tilted to a receiving position.

The next step for the hot metal in the process of refinement is to convey it from the converter to the open-hearth furnace. This is done very much as was the previous operation, except that the hot metal is poured from the converter into another ladle mounted on a ladle car and is transferred by steam or electric locomotive to a point before the open-hearth furnace. Here, it is hoisted free of the car and poured into the furnace by means of an overhead crane. The track over which this car travels is indicated in Fig. 6 by the note "Hot Metal to Open-Hearth Furnaces."

Fig. 7 shows a 65-ton ladle car that may be used for this transferring operation.

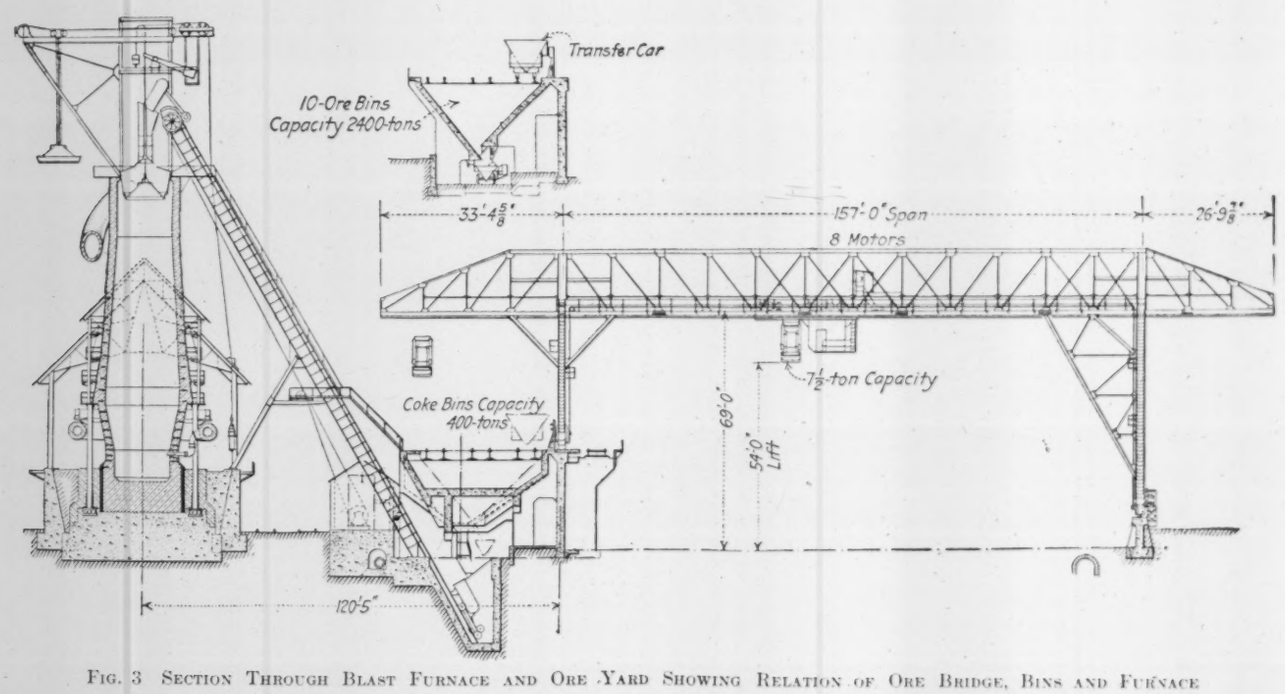

Fig. 3 Section Through Blast Furnace and Ore Yard Showing Relation of Ore Bridge, Bins and Furnace

Open-Hearth Furnaces

Scrap, ore and limestone are conveyed to the open-hearth furnace in cast-steel boxes called charging boxes, three or four of which are moved on a specially built car. The scrap is placed in the boxes by means of the overhead crane and a magnet. The ore and limestone are handled either by the crane and a grab bucket in cases where it is necessary to move them from storage piles to the boxes, or they are placed in the boxes direct from bins by means of chutes, when the plant is so provided. The cars are then hauled in trains to the charging floor of the open-hearth furnace building.

It occurs to the writer that the ore and limestone used in open-hearth practice could be handled more economically if they were either stored in bins under the approach trestle to the open-hearth

building and discharged by chutes into the charging-box cars, or if they were stored in bins under the open-hearth floor and removed by means of a grab bucket, or possibly by the application of mechanically operated proportioning devices used in conjunction with compartment bins discharging them to the charging floor of the open hearth.

In the methods now in vogue the train of loaded charging boxes is transferred from the storage yard to the open-hearth charging floor in front of the furnaces by means of an electric or steam locomotive. The material in the charging boxes is then dumped into the furnace by an electric charging machine. This machine lifts the charging box into the furnace where it dumps its contents by turning the box through a complete revolution. The operator of one of these machines sometimes takes a loaded box and uses it as a means of leveling the charge within the furnace much as a fireman would use a poker to level the coals in the firebed of his boiler.

The products of the open hearth are steel and slag. The steel is drawn off from the furnace and run into a ladle of a size consistent with the capacity of the furnace. In the Talbot system only half of the charge is drawn from the furnace at one time. After the ladle is filled it is transferred by an overhead crane to a position over the first mold of a train of ingot molds.

The slag which flows off at the time that the steel is tapped is run into a slag ladle mounted on a special car by which the ladle is carried to a suitable point for dumping. The position of this car is indicated on Fig. 6 by the letter (A). It is placed there to receive the slag during the tapping of the furnace and is hauled away afterward on the track indicated by the note.

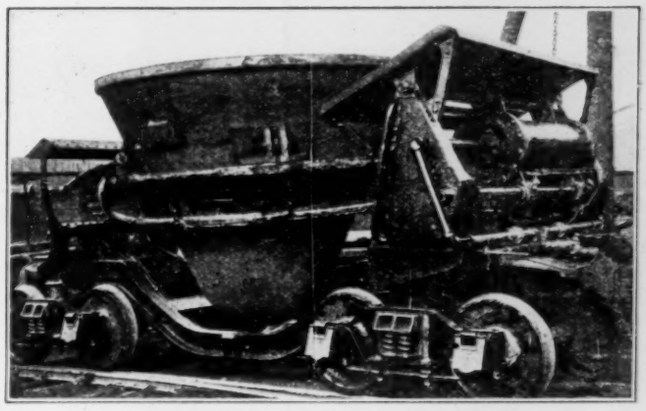

FIG. 5 SLAG CAR AND LADLE

heads and notes as they travel from the open-hearth pit to the stripping yard.

The stripping process simply means removing the molds from the cast ingots after the metal has hardened sufficiently. Fig. 8 shows an ingot stripper and indicates how the hooks of the stripper engage the ears of the mold, lifting it clear of the ingot car and leaving the ingot on the car. When the mold has been used for a long time it may become slightly pitted, causing the ingot to stick when it is being stripped from the mold. Under these circumstances it is necessary to drive the ram down into the opening at the top of the mold to force out the ingot.

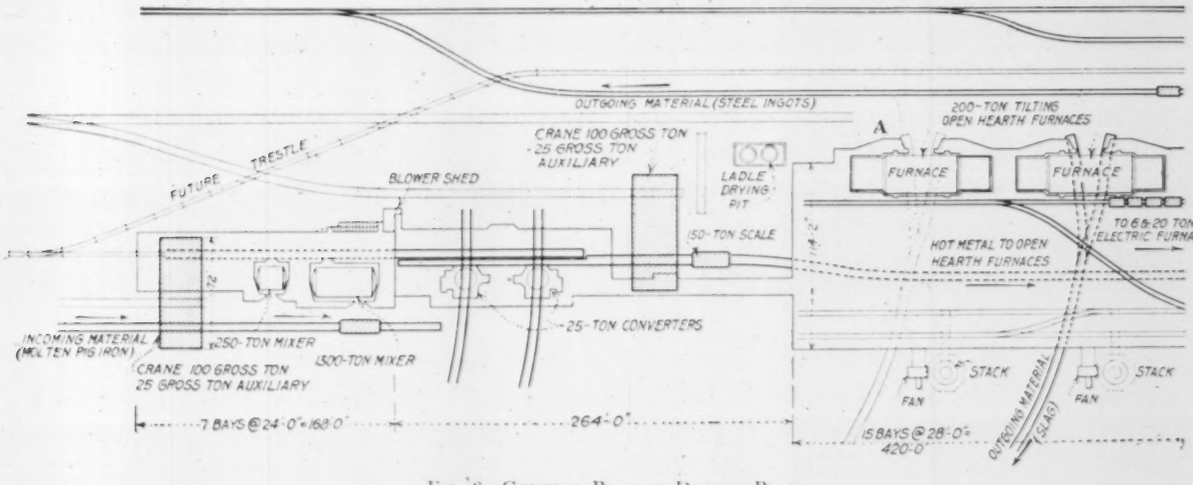

FIG. 6 GENERAL PLAN OF DUPLEX PLANT

The molds in which the steel is cast are mounted on cars, usually three or four molds to the car. These cars are heavily constructed as they must withstand having molten metal splash on all parts of them or the dropping of an ingot from a height of several feet when the mold is being stripped from it.

The direction of travel of these ingot cars is indicated by arrow

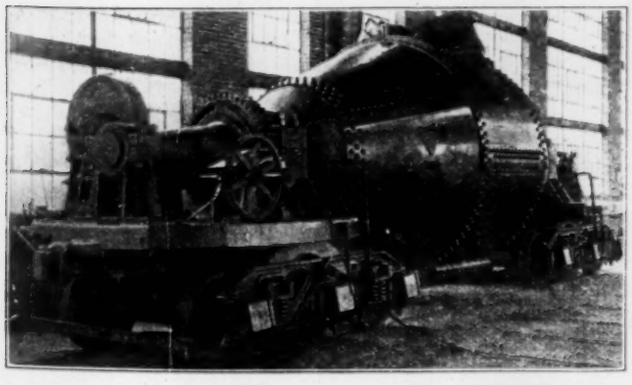

FIG. 4 PUGH MIXER-TYPE HOT-METAL CAR

The train of stripped ingots is now moved from the stripper yard to the soaking-pit furnaces, or to a suitable storage yard.

A MODERN ROLLING MILL

Fig. 9 shows a plan of a modern rolling mill in which nearly all the different types of material-handling machinery that have been developed to the present time for this industry are used.

This plant includes a 40-in. two-high reversing blooming mill, a 24-in. and 18-in. sheet-bar and billet mill, and a 28-in. rail and structural mill. Provision has been made for serving a 12-in. and 8-in. merchant mill with billets from this sheet-bar and billet mill. All mills are electrically driven. The different types of conveying machines are indicated by letters, in the order in which the material travels.

The blooming mill is served by six 4-hole soaking pits, in which the ingots are placed by an overhead electric tong crane. This crane handles the ingot on a principle similar to that of a pair of ice tongs. The operator's cage rides with and above the tongs, enabling him to place the ingots in the proper position in the pits.

The next step in moving the material is to serve the blooming mill with hot ingots from soaking pits. The soaking-pit crane delivers the ingot to a tilting buggy, places the ingot on roller table

(B), and it is directed properly for entering the rolls of the blooming mill by manipulator (C).

Fig. 10 shows a general view of the soaking-pit furnaces and the end of a roller table, to which an ingot is being delivered by the traveling tilting buggy. This buggy travels back and forth in front of the soaking pits, operated either by a remote-control switch which places the buggy at any desired position on the track, or motivated by an electric tractor—man-operated. In case of breakdown of the ingot tilting buggy the cranes can place the ingot directly on the table.

As previously stated, the manipulator is a machine used to place the ingot in the proper position for entering the rolls, and to turn or shift it for the next pass after passing back and forth through them. The modern manipulator is hydraulically operated. Its pushing arm has both a vertical and horizontal movement and is provided with a movable side guard on each side with tilting heads on one side for turning the section being rolled. This enables the operator to place the material at any desired position before the rolls.

Many mills are equipped with manipulators on both the entering and delivery sides of the mill, but when they are placed on the delivery side the tilting heads are omitted.

After the ingots have been reduced to blooms, slabs, or blanks by the blooming mill they are carried to the shear by another electri-

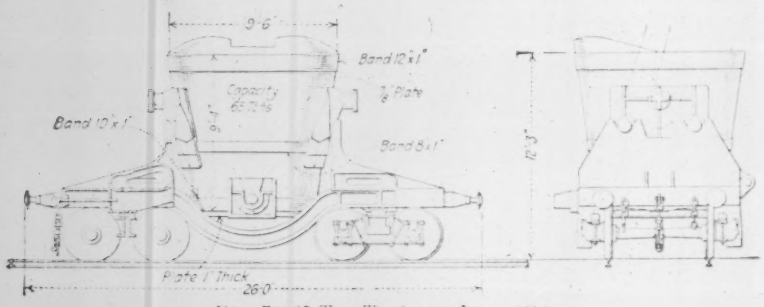

Fig. 7 65-Ton Transfer-Ladle Car

cally driven roller table indicated in Fig. 9 as table (D). The shear cuts the blooms to required lengths, removing the fan tail end or crop end, as it is termed in the mill. This crop end is dropped down a chute at the shear to conveyor (E) which conveys it to a bloom-butt car located on the track next to the mill building. This conveyor is usually very heavily constructed, and, due to the irregular shapes handled, it is built so that the billets are pushed along on a smooth surface of plates by a traveling scraper conveyor which will handle any size or shape likely to be produced by the mill.

In some plants open-hearth charging boxes are placed on a charging car and the crop ends are loaded directly into the boxes by the crop-end conveyor. This is desirable where the distance between the blooming mill and the open-hearth is not great. If the distance is too far, too much money is tied up in charging boxes, due to the quantity necessary to provide for delays in transportation, etc.

The mill layout shown in Fig. 9 provides for distribution of blooms and blanks to the rail and structural mill by means of conveyor (F) and slabs and blooms to the hot hole or shipping yard by means of conveyors (G) and (H). It also provides for distribution of blooms and blanks to reheating furnaces or to rail mill by means of conveyor (F), table (J) and charging cranes (K) when reheating for rail mill, or for blooms and slabs direct to the sheet-bar and billet mill by table (L). Conveyor (F) shown in Fig. 11 is constructed with a surface of heavy tee rails, on which the billets are skidded along by rapidly traveling dogs. The dogs run on tracks between the rails and are attached to wire ropes running around an idler pulley at one end of the bed and a driving drum at the other end. This conveyor must handle the blooms rapidly as they are sometimes passed from the blooming mill direct to the rail and structural mill without being reheated.

Fig. 12 shows another type of these conveyors and also the grasshopper type of pusher, a machine used for removing material from a roller table to a conveyor placed at right angles to it.

The feature of this machine is the peculiar path which the ram describes in passing through one cycle of operation. The levers are arranged to cause the ram to travel in practically a horizontal straight line in the forward stroke, while on the return stroke it describes an arc in an upward direction, clearing material that may be traveling out from the shear.

When it is desired to deliver material to the hot hole it is removed from the shear table by means of the grasshopper pusher, to either conveyor (G), Fig. 11, in the case of slabs, or to conveyor (H) in case of blooms or blanks.

When slabs are delivered to conveyor (G) it transfers them to a slab piler which arranges them in piles of four or five. They are then removed by the overhead crane to be stacked in the hot-hole yard and allowed to cool.

The same procedure takes place when blooms are delivered to conveyor (H), except that the blooms are delivered to a cradle from which they are removed to the hot-hole yard for cooling and storage.

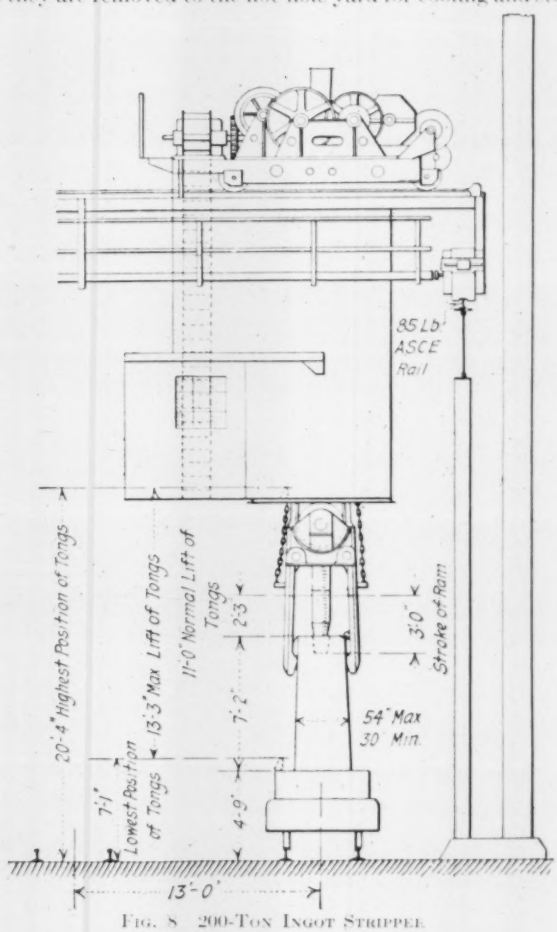

Fig. 8 200-Ton Ingot Stripper

The roller table indicated by reference (L), Fig. 9 is the ordinary type of electric-driven table.

Many types of machines have been developed to replace the old-style hand methods of replacing heavy billets, bars, etc., in the furnace for reheating, preparatory to rerolling. Reference (K), Fig. 9, indicates the location of two of these machines which travel on girders above the furnaces. They are designed so that the tongs may be placed in any position necessary to serve the furnaces on either side of the charging floor.

In the plant shown by Fig. 9 the charging crane (K) can pick up the material from the skids at the end of table (J) and place them in the furnace; store material at the end of the runway for future use; remove hot material from furnaces, and serve either the sheet-bar and billet mill or rail and structural mill. This arrangement allows many methods of operation between the different mills.

Sheet-Bar and Billet Mill

When it is desired to reduce the blooms to billets or flat bars they are conveyed direct from the blooming-mill shear to the 24-in.

mill by table (L) and rolled in the 24-in. mill without reheating. Some few sections, however, require reheating and the blooms for these are taken from table (L) by charging crane (K), placed in reheating furnaces, then returned to table (L), and to the 24-in. mill. After passing through the 24-in. mill they are delivered to the 18-in. mill by table (M), where the cross-sectional area of the bar is still further reduced. If it is not necessary to pass the bars through the 18-in. mill they are delivered to the stockyard or cars by means of a cooling-bed transfer conveyor (N), roller table (O) and transfer (P).

If it is necessary to pass the bars through the 18-in. mill they are conveyed to same by table (M). This table is designed with the axis of the rollers set at an angle of about 102 deg. with the center line of the table instead of 90 deg. for the purpose of throwing the bar off the table on to transfer conveyor (N). If it is desired to deliver the material to the 18-in. mill instead of placing it on transfer table (N) it is guided into a groove which is on the circumference of each roller, these grooves being in line on the table. Naturally this causes the material to follow a straight course to the 18-in. mill instead of being thrown off the table by the skewed arrangement of the rollers. After passing through the 18-in. mill the bars are cut to size by a rapidly operating shear, the knives of which move forward with the bar, cutting it as it rolls along. This type of shear is called a flying shear. The bars are then conveyed to cooling bed (Q), where they are allowed to cool, and transferred by the cooling-bed conveyor to a bar piler at the end of the conveyor. The bundles of steel bars or billets are then transferred to the billet storage yard, or to the merchant mill for further reduction to small shapes, or directly into cars for shipment by overhead crane (R).

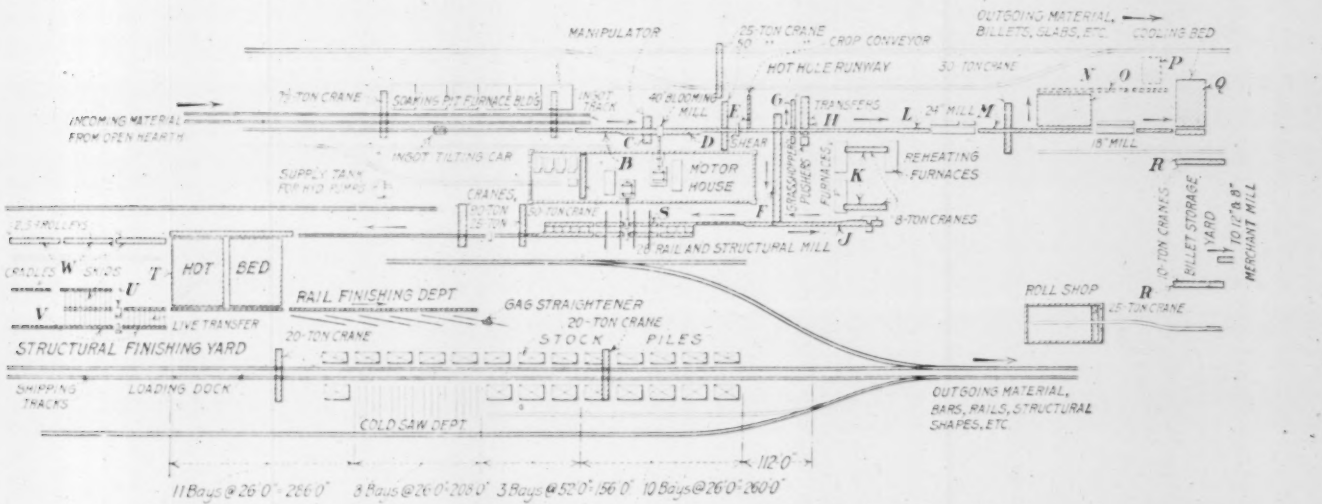

FIG. 9 GENERAL PLAN OF 40-IN. BLOOMING MILL AND SHEET-BAR AND BILLET MILL

28-INCH RAIL AND STRUCTURAL MILL

As previously mentioned, it is possible to deliver blooms from the blooming mill direct to the rail and structural mill by means of conveyor (F), thereby continuing the reduction of the bloom in the rail and structural mill without reheating. If it is desired to reheat the bloom, it is carried by means of conveyor (F) and roller table (J) to the end of table (J), where it is pushed on to the skid table, picked up by a charging machine (K), and charged into the reheating furnace. When properly heated it is returned to roller table (J) by charging machine (K).

Table (J) is designed with a double set of rollers so that blooms delivered to it may pass in either direction on both sides at once. The advantage of this can easily be understood; for example, conveyor (F) may be delivering material to the furnace on one side of the table and at the same time material may be transferred from the furnace to the rail and structural mill on the other side. This arrangement is shown on Fig. 11 by a light outline of the cross-conveyor at the delivery end of the conveyor.

If the bloom is to be rolled on the 28-in. mill it is carried to the mill by table (J) and a traveling tilting table (S). Two of these traveling tables are located on either side of the 28-in. mill and serve the purpose of catching the bloom as it travels back and forth through the mill. When the cross-sectional area of the bloom has been reduced to as small as is desired on the first stand, it is pushed over to the second stand by means of rope-propelled dogs which travel back and forth between the skid rails of a stationary transfer. The traveling tilting table (S) moves the material from pass to pass in either the top or bottom pass, as required. In event of either table breaking down, provision is made for removing the table beyond the face of the rolls where repairs can be made, and one table is used for both stands, which of course lessens production. When the roughing out is completed on the second stand of the 28-in. mill the material is passed to the finishing stand of the 28-in. mill. Here it is given one finishing pass of either a rail or structural shape and passed on to the saws by another power-driven roller table.

If the finished material is a rail it is generally cut into three pieces of standard length simultaneously by four drop hot saws, the two end saws being used to remove the crop ends of the rail. If a structural shape, it is cut by the sliding saw indicated to lengths desired. The material is then delivered to the cooling bed (T), on which it is drawn across by dogs attached to wire ropes or some other of the many methods of propulsion that have been designed for this purpose.

Rails are delivered in one direction to a rail-finishing department and structural shapes in the opposite direction to a department for finishing I-beams, channels, angles, etc.

When finishing structural shapes they must be straightened and the ends cut true. Fig. 9 shows a modern arrangement for transferring shapes from the cooling bed to the straightener (U) and thence to the shears, by means of transfers (V). When shapes have passed through this last stage of finishing they are removed from the shear cradle by means of overhead cranes (W) and placed in piles for storage or directly in railroad cars for shipment.

Rails pass through a similar process of straightening and end finishing and are also drilled. They are conveyed from the cooling bed on roller tables, and transferred to the different finishing machines on idler rollers supported on individual stands.

The writer is of the opinion that the methods of handling rails in the finishing department can be materially improved and more of the manual labor eliminated by plant arrangements different from those used at the present time. Not enough power-driven machinery is used in this work. This problem could be studied with beneficial results.

The foregoing description gives a general idea of the types of material-handling machinery used in a steel mill, but of course does not cover all the variations that would naturally be required in manufacturing different forms of steel. For example, there are several types of mills which have not been mentioned, all of which require material-handling equipment suited to the type of material handled.

FIG. 10 GENERAL VIEW OF SOAKING PITS, INGOT TILTER AND TONG CRANE

The mill for manufacturing steel plates requires lighter but broader tables, and toward the finishing end chain conveyors are used to handle the plates. At the shears an arrangement of castors set up on spindles is used, allowing the plate to be placed at any desired relation with the shear. This arrangement is known as a castor bed.

writer that there is greater chance for improvement in handling equipment in this type of mill than any other, as a vast amount of work is still done by hand.

Continuous furnaces for heating sheet bars have been developed to replace the old reverberatory hand-charged type. These furnaces are fed by a special pusher arrangement, which places the sheet bars in the furnace in piles. Before they are removed these piles must be scattered, which is done on a hearth at the outlet of the furnace, thereby allowing thorough heating, and facilitating the removal of the bars from the furnace to the mills for rolling. The bars are transferred to the mill by hand, except in the case of jobbing mills handling bars for making light plates, where a mechanical arrangement is used. It is the opinion of the writer that some such method could be used to advantage on most sheet mills, especially where long sheets are made requiring a maximum-sized sheet bar to begin with.

The mechanical doubler used for doubling the sheets in rolling to finer gages, is one recent improvement which eliminates the disagreeable task of doing this work by hand or by the old-style cylinder-operated clamping machine.

This point of steel manufacturing is sadly lacking in material-handling equipment, and is a fertile field for development. Material is moved by hand to and from furnaces, to and from shears, and through the finishing processes of sheets, to an extent which should be eliminated by roller tables, chain conveyors, or even overhead monorail trolleys, any one of which properly installed would lighten the load now placed on human shoulders.

It might be said that the tube mill is a continuation of the plate or skelp mill, where tubes are made by bending up and lap-welding the plate or drawing the smaller-sized skelp through a bell-shaped die to be butt-welded. Material-handling machinery for this type of work is well developed, and through the use of overhead cranes,

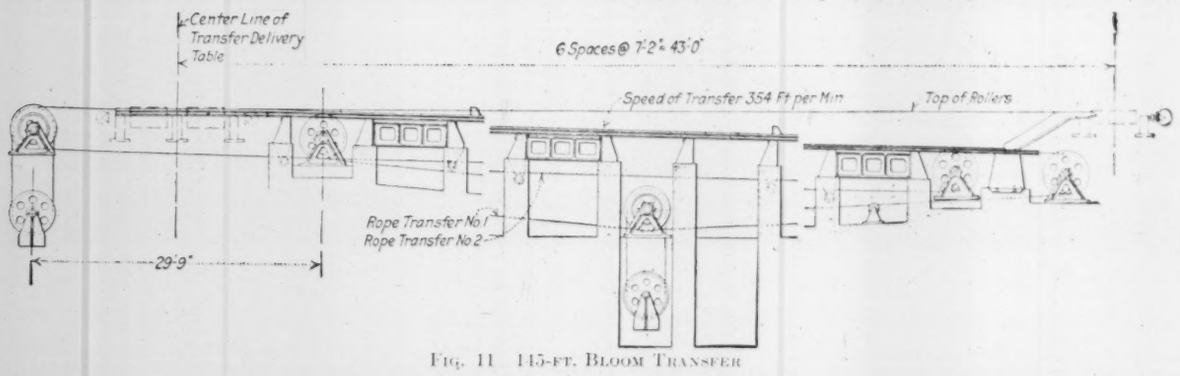
Center Line of Transfer-Delivery Table
6 Spaces @ 7'-2½" = 43'-0"
Speed of Transfer 354 Ft per Min
Top of Rollers
Rope Transfer No 1
Rope Transfer No 2
29'-9"

FIG. 11 145-FT. BLOOM TRANSFER

The skelp and rod mill requires light tables and conveyors which will handle the rolled material rapidly, as the mills used for this work are small and run at a high rate of speed. They also require long cooling beds that will handle the material in such a manner that it is straightened while cooling. The Edwards escapement bed is a good example of this type, and is shown by Fig. 14. The rods are delivered to the top of the bed by a conveyor having a set of cone-shaped rolls. These throw the rod to the small end of the roll, which retards the speed of the rod and allows a set of fingers to pick it up and place it on the first of a series of spurs on an inclined bed. As each rod passes out from the mill it is picked up and placed on this inclined bed, and as each is dropped on the bed the preceding rods are dropped down one spur at a time until they reach the bottom. This intermittent dropping from one spur to the other straightens the rapidly cooling rod, so that when it reaches the bottom it is straight enough for ordinary purposes. The rod is then pushed out on to a roller table at the bottom of the cooling bed, and conveyed to the shear where it is reduced to the desired length. In some cases where the rods are small in diameter, for example $^1/_4$-in. and $^5/_{16}$-in., they are passed from the mill direct to coiling reels, where they are coiled into bundles and placed on a slow-moving coil conveyor. This allows the bundles to cool before being placed in storage piles or on cars for shipment.

SHEET AND TUBE MILLS

Although material-handling equipment in sheet mills has improved considerably in the last few years, it is the opinion of the

conveyors, special pushers, etc., the manual handling of material is almost entirely avoided.

FORGINGS

Heavy forging is another branch of the steel industry that requires special handling machinery. Fig. 13 shows a manipulator

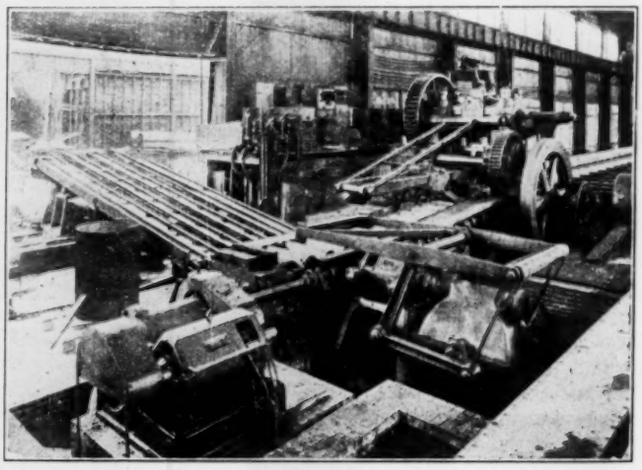

FIG. 12 BILLET CONVEYOR AND GRASSHOPPER PUSHER

which when controlled by a skillful operator can handle a 3-ton forging with as great dexterity as a blacksmith handles a horseshoe. Such a machine may also be used to feed material into rolling mills of different types. Primarily, it is operated by three motors. The first controls the vertical travel of the end of the peel, the second rotates it on its own axis and the third moves it laterally by turning the car body on the truck. A hand wheel controls the height of the rear or pivotal end of the ram so that it can be kept as nearly horizontal as possible. Two sets of springs are provided to give flexibility in both a vertical and horizontal direction and the tongs are operated with compressed air furnished by a compressor mounted on the frame. The whole machine is moved on its track by two motors on the truck.

MISCELLANEOUS EQUIPMENT

Many types of conveyors are used in steel-plant auxiliary equipment, such as gas-producing plants, power plants, coal-pulverizing units, etc.

Among the most novel of these is one type of modern plant for pulverizing coal, in which the pulverized coal suspended in air is conveyed about the plant in pipes. The lump coal is delivered to this plant by gondola cars, dumped into a track hopper, passes to

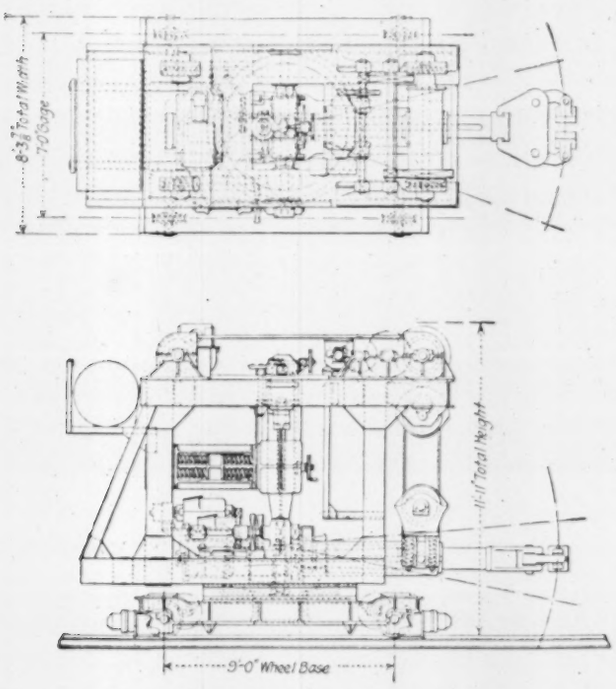

FIG. 13 ALLIANCE THREE-TON FORGING MANIPULATOR

a crusher by means of a reciprocating feeder, and from the crusher is conveyed to an overhead storage bin by a gravity-discharge bucket conveyor. At the base of the storage bin is a belt conveyor which delivers the crushed coal to a drier. In some cases the coal is delivered from the drier to the pulverizers by an enclosed bucket elevator and in others by a chute, depending on the relation of the driers to the pulverizers. This is the point where the system of using air to convey the coal is employed. A blower is used to induce a current of air into the pulverizer, blowing the fine coal dust out of the top of the pulverizer through a pipe up into a cyclone collector. Here the coal dust is allowed to settle into a bin, the air being drawn out of the top of the collector by the same fan, which again passes it through the pulverizer to pick up more coal.

The pulverized coal is conveyed from the storage bin by means of screw conveyors to a heavily designed, powerful blower, which blows the coal through a circuitous system of piping to the points where it is to be burned, the surplus coal returning to collectors, which again allow it to settle into the storage bin. This system has been successfully installed in several large steel plants where the pulverized coal has been used for open-hearth furnaces, reheating furnaces and boilers.

The many types of conveyors, such as bucket elevators, scraper

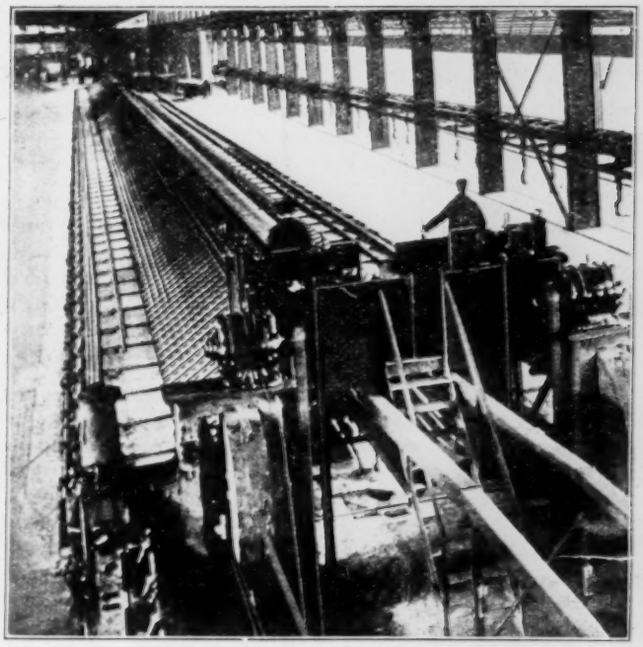

FIG. 14 EDWARDS DOUBLE-ESCAPEMENT-TYPE COOLING BED

conveyors, etc., which are used about a gas-producing plant are too numerous to mention and too well known to require description.

POWER

Nearly every known type of power has been adapted to material-handling machinery about a steel plant. Steam and hydraulic power have been used quite extensively, but are both being gradually replaced by electricity. Air under various pressures has also been adapted to many types of pneumatic machinery. Hydraulic pressure is used on heavy slow-moving machines, tilting open-hearth furnaces, ingot tilting pots, manipulators, shear-depressing and tilting tables, etc. Most of these types of machinery are now being handled by electrically driven cranks or racks.

GENERAL

To summarize the problem of material handling in the iron and steel industry, it is quite apparent that there are many gaps in handling material from the ore mines to the finished steel which can be improved, even with the present methods of manufacturing. Notably among these are the methods of conveying raw materials to the open-hearth furnace, and the many steps required from the blast furnace to the finished steel ingot. In other words, they include the rehandling of material several times to obtain the desired refinement of steel, which is especially important where most of the material is handled in a molten condition with its consequent high cost. It is the author's opinion that this refining process will change materially in the next few years through the medium of electricity, and as central power plants become more highly developed and more of our natural resources are put into use to obtain cheap electrical power, furnaces will be developed that will operate by a continuous process. They should be able to take the ore at one end of the furnaces, and with the addition of material at different points obtain the alloy desired at the pouring end, thereby eliminating the handling now required from one furnace to the other by miscellaneous containers, ladles, etc.

In reducing ingots to the finished steel product, improvements should be made which will increase the safety of working conditions and eliminate as much as possible by proper ventilation at the mills and well-ventilated operating pulpits located at a distance from hot work, the disagreeable conditions arising from heat. Machinery should also be developed, wherever possible, to eliminate the necessity of handling hot steel with tongs around bar mills, rod mills, sheet mills, etc.

There is without a doubt a vast field for research and improvement in this industry, as there is in all others, and it is for us, as engineers, to continue our endeavors and bring out these improvements.

Centrifugal Casting

A Résumé of the Development and a Discussion of the Design and Operating Problems of Centrifugal-Casting Processes and Their Field of Application

By LEON CAMMEN,[1] NEW YORK, N. Y.

In this paper the author describes the process of centrifugal casting of hollow metal objects. He first deals with the field of centrifugal casting and the history of the development of the art and then discusses the mechanics of the problem and describes the operation of the casting machine. Following this he takes up the thermal conditions in the mold and the field of application of hot-mold centrifugal casting, closing with a discussion of the manufacture of plates by the centrifugal-casting process.

THE centrifugal casting of metals is an old art, but it did not assume commercial importance until the last decade. Since then, however, while it has not attracted much public notice, its progress has been very rapid. It has already become an important factor in such work as the manufacture of paper-mill rolls and railroad car wheels. It is today the most vital problem before the makers of cast-iron pipe in the United States, and, with its recent developments, promises to revolutionize the two most profitable lines of the great steel industry, namely, tubular goods and plate manufacture. In the present paper it is intended to describe the process of centrifugal casting of hollow metal objects. The field of centrifugal casting is, however, far more extensive. The process has been successfully applied in the production of non-metallic tubes, such as concrete pipe (Hume process and others), in the production of solid castings by locating the molds around the rim of a spinning wheel, and also to a limited extent in the production of solid ingots by a largely similar process.

The field of application of centrifugal casting is far more extensive than is generally realized and the process is already being worked on a large scale. In the first place, centrifugal casting is a cheap method of producing goods of certain shapes, namely, those having a hollow interior symmetrical about an axis passing through the body of the casting, whether concentrically or eccentrically. The advantage of such methods lies in the fact that with proper equipment a very large number of units can be produced with comparatively little labor and without the use of cores, and that a greater homogeneity of metal is obtained than is possible with the ordinary method of casting. During the war several concerns employed this method, for example, for the production of piston rings for automobile engines, and even now establishments like the Ford Motor Company continue to use it for that purpose.

The Sandusky Foundry and Machine Company, Sandusky, Ohio, employs centrifugal casting to produce bronze paper-mill rolls and propeller sleeves, which would be much more expensive and probably less satisfactory if cast in a stationary mold. The Stokes Casting Co., Ltd., Mansfield, England, has used the same method for making cast-iron liners for aluminum cylinders of internal-combustion engines of such a small thickness and high grade of metal that they could not be duplicated by any other process except machining, and at a price only a small fraction of what a machined tube would have cost.

In the field of cast-iron pipe centrifugal casting is in a fair way to displace sand-molded pipe entirely. The method of centrifugal casting of cast-iron pipe has been primarily developed by a Brazilian engineer, Dimitri Sensaud DeLavaud, and has been extensively employed in England, Canada and Japan. Some months ago the United States Cast Iron Pipe and Foundry Co., of Burlington, N. J., one of the largest manufacturers of cast-iron pipe in the world, acquired the DeLavaud patents for America and are going into the manufacture of centrifugally cast cast-iron pipe on a large scale. It is stated that they can make 600 lengths a day with 25 men and the centrifugal process, as against 400 lengths with 80 men by sand molding, in addition to which centrifugally cast pipe is roughly 15 per cent stronger than sand-cast.

[1] Associate Editor, MECHANICAL ENGINEERING.

Abridgment of a paper presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. All papers are subject to revision.

Another development in centrifugal casting in this country which has already become of commercial importance is the manufacture of railroad wheels. The idea itself is not new and there are English patents describing it dating back to the early sixties. As cast centrifugally by the American Steel Foundries, the wheel has a manganese-steel rim and a soft-steel hub and spokes, the depth of penetration of manganese in the rim being regulated at will.

Of late, centrifugal casting has acquired a further importance in the development of a method by which tubes and hollow billets may be successfully cast of such metals as monel metal and alloy steels, which can neither be cast into thin-walled tubes nor pierced by the ordinary methods. Recent developments in the art are such as to open really great possibilities for the future, a matter which will be discussed in a later part of this paper.

The art of centrifugal casting of hollow metal objects is quite old and has been practiced on a commercial scale since the beginning of the last century. The earliest English patent (Eckert) dates as far back as 1809, and the earliest American patent to Lovegrove was issued in 1848. At about the same time Andrew Shanks, in London, England, began to make cast-iron pipe 12 ft. long and 3 in. in diameter by pouring molten metal into a spinning wrought-iron mold. His process was described in America in the *Scientific American* of December 1, 1849, and it is of interest to note that in its basic features of design the Shanks machine does not differ in any way from the great majority of machines working with a cold mold at the present day.

Attempts were made at an early date to apply centrifugal casting to ingot making with the view to improving the quality of the metal and, for example, M. Tresca, in a paper before the Institution of Mechanical Engineers,[1] stated that the most remarkable instance he had met with of freedom from air bubbles was in the case of a bessemer rail manufactured at the Imphy Iron Works near Nevers in the Department of Niévre, France; and he had ascertained that the method adopted at this plant was to pour the molten metal into a revolving vessel driven at a considerable speed so as to clear the steel of air by rapid rotation. This method proved very effective in practice in freeing the steel from the minute air bubbles which it contained on leaving the converting vessel or the melting pot.

A survey of the literature and of the numerous patents issued on centrifugal casting in this country and in Europe would indicate that practically all the essential features were covered by patents issued prior to the beginning of the twentieth century, with the exception, however, of those dealing with the temperature control of the metal, which is a new feature. It would appear, therefore, that with the exception of minor details and one or two features in special casting processes, there is no reason why any good engineer cannot design and operate a successful casting machine with a non-heated or non-cooled mold without running into legal complications. At the same time, it might be well to realize that the very fact that the basic features of the general process are already free makes those who have developed some of the few minor features particularly anxious to protect their patent rights in them. Because of this a general familiarity with the patent situation is desirable to avoid involuntary infringement by using some minor detail that has been covered by a patent.

MECHANICS OF CENTRIFUGAL CASTING

In the first place, a clear distinction should be made between casting about the horizontal and about the vertical axis and also the intermediate case of an inclined axis. In casting about a horizontal axis the metal is distributed symmetrically about the axis of rotation, and if the axis of rotation coincides with the axis of the spinning unit, a tube of uniform thickness is produced for

[1] Proc. Inst. M. E., 1867, pp. 149–150.

the entire length of the mold. If a vertical axis is used it is obvious that the external wall of the casting follows the shape of the mold, while the interior of the casting forms a paraboloid of revolution. In casting with an inclined axis the same general principles apply, with the further complication that the elements of the inside paraboloid of revolution are also affected by the angle of inclination of the axis to the true horizontal.

The usual way of casting is by introducing molten metal into the spinning mold. Where the chilling of the metal is extremely rapid, as, for example, in casting cast-iron pipe against a water-cooled chilled mold, it is imperative to use a movable spout, the latter sliding at a certain predetermined rate so that by the time the nozzle discharging the metal comes out of the mold the entire pipe is completed. This is the process employed by DeLavaud. Other manufacturers working with the cold mold have attempted to secure the same results by what is known as a trough spout, which is really a trough into which the entire metal of the casting is poured at a rapid rate. The trough is then tipped and discharges the metal suddenly, the metal falling on to the walls of the mold at such a rapid rate that a pipe forms before the metal has had time to chill. Hitherto this process has met with only indifferent success.

A better result has been achieved on comparatively short castings, however, by the use of a ledge spout, the spout ending in a flat ledge along which the metal can flow the entire length of the casting. Finally, where a hot mold is used an ordinary short spout is employed, the metal distributing itself throughout the mold longitudinally under one of the components of centrifugal pressure or pressure produced by centrifugal action. This arrangement cannot be used with a cold mold.

In centrifugal casting the distinction should be clearly made between jobbing work and mass production. For the former, clay molds in iron cases have been used practically exclusively, as it would not pay to make a permanent mold for only a few castings. When it comes, however, to production on a tonnage basis, such as tubing or pipe, a permanent mold is practically the only feasible way. Crucible graphite or zirconium tubes have been successfully used for castings not in excess of 3 ft. in length, but when it comes to longer ones, metal molds are to be preferred. Fairly successful results have been obtained with chrome-nickel alloys, though it is not expected that this will be the material finally adopted, as enough work has been done already on the production of cast tungsten to make it certain that a mold of this still rather mysterious material will be available within a comparatively short time.

There are several ways of supporting the mold in the spinning bench, depending on whether the mold is a permanent fixture or removable and also on its size. Where the mold is a permanent fixture—as it is today wherever a cold mold is used, any kind of bearings, provided they are substantial enough, may be used. With removable molds the conditions are somewhat different, especially where the mold is heated to a high temperature. Where extremely hot molds have to be used, the arrangement must be such that the stresses on the mold can be reduced to a minimum, and that the mold can be rapidly and easily inserted into the machine and extracted therefrom. The matter of stresses is of very great importance in view of the fact that, especially in large machines, the bursting stresses due to the action of centrifugal force are of such magnitude as to require the most serious consideration.

The spinning bench for removable molds such as shown in Fig. 1 works on a comparatively simple principle, the mold being held in a barrel rotating on rollers, on which the pressure is adjusted by the wheel and screw shown at the top of the A-frame. This figure does not show the method of supporting the mold, and moreover, except for the very small sizes, three rollers are not sufficient.

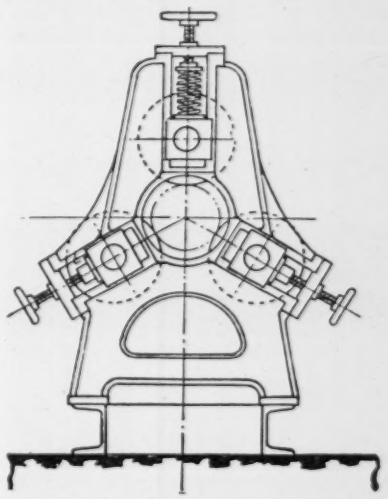

FIG. 1 SPINNING BENCH FOR REMOVABLE MOLDS (SUITABLE ONLY FOR SHORT AND LIGHT MOLDS)

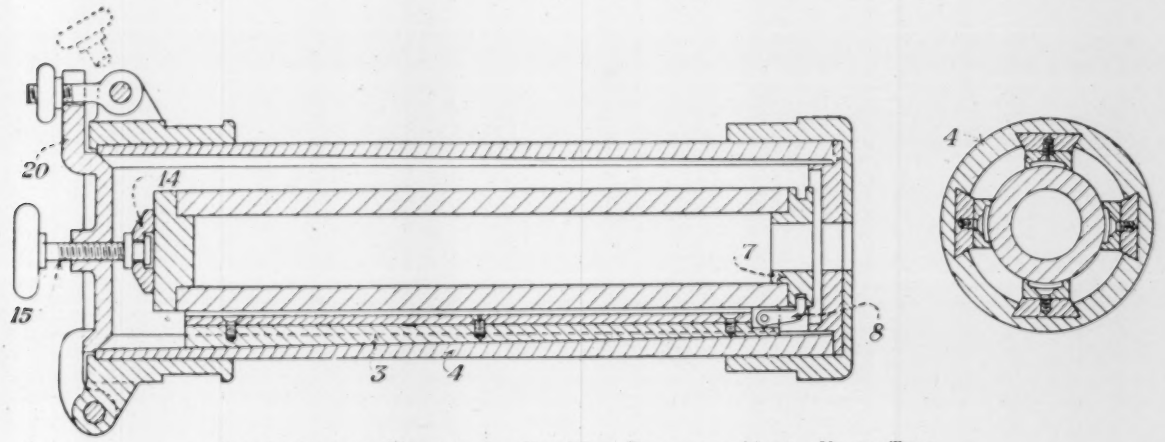

FIG. 2 SPINNING MACHINE FOR USE WITH REMOVABLE MOLDS, HEAVY TYPE

The barrel construction shown in Fig. 2 is far more suitable for use with hot molds. Here the barrel consists of a steel shell, 4, which may be an extra heavy steel pipe, but in sizes above 12 in. has to be made as a special casting. At four to six places symmetrically spaced along the inner circumference of the shell, steel strips tapered at 39 and 40, Fig. 3, and with faces machined to the same radius as that of the internal surface of the shell, are screwed on or riveted on. The strips are provided with truncated slots as shown in the figure, and in these slots move the keys or gibs 51, the cross-section of which is shown by 37 and 36, which indicates that the face 36–37 is of the same width from one end of the gib to the other but the height of the trunk varies.

It is obvious that as long as the four gibs move through the same distance longitudinally in their tapered beds the faces of the gibs will remain parallel to each other, but the enclosed cylinder tangent to those faces will vary in diameter with the position of the gibs.

The operation of the machine is therefore as follows: The head 20 is opened and the gibs pulled out a little way until the tangent

cylinder is, say, a quarter of an inch larger than the external size of the mold. The mold is then inserted, preferably without touching the gibs, until it comes to bear against the abutment ring 7, to which all the gibs are attached (for example, by hooks 8). As the mold presses against the abutment the latter recedes and carries with it the gibs, which by moving in their tapered beds gradually close in until they grip the mold; and they may be made to grip it as hard as desired simply by exerting sufficient pressure on the abutment 7, which may be done by means of the block 14 and the screw 15.

The great advantage of this construction lies in the facts

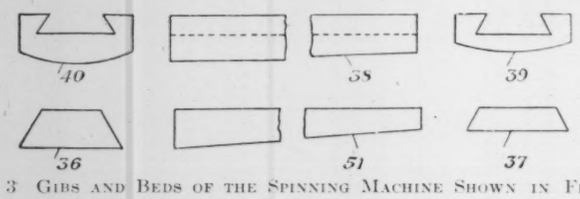

FIG. 3 GIBS AND BEDS OF THE SPINNING MACHINE SHOWN IN FIG. 2

that, first, the mold automatically finds its own center, and, second, that it is supported all along its length, a matter of great importance when we come to deal with the bursting stresses in the mold. Whether a solid or a split mold should be used is a matter determined primarily by the shrinkage conditions of the metal of the castings and the metal of the molds. Where these are such that the casting comes out of the mold easily, that is, where it contracts quicker than the mold, a solid mold may be used, but where the shrinkage conditions do not guarantee easy extraction of the casting, or where they are non-uniform, the use of a split mold has been found advisable. Such molds are usually split longitudinally and the question of the best method for holding the two parts together is far less simple than it appears at first sight. There are numerous patents showing the two split parts of the mold held together by bolts. In actual construction, however, the use of bolts for this purpose is entirely unsuitable, for it can be shown that either bolts of prohibitive size would have to be used or the

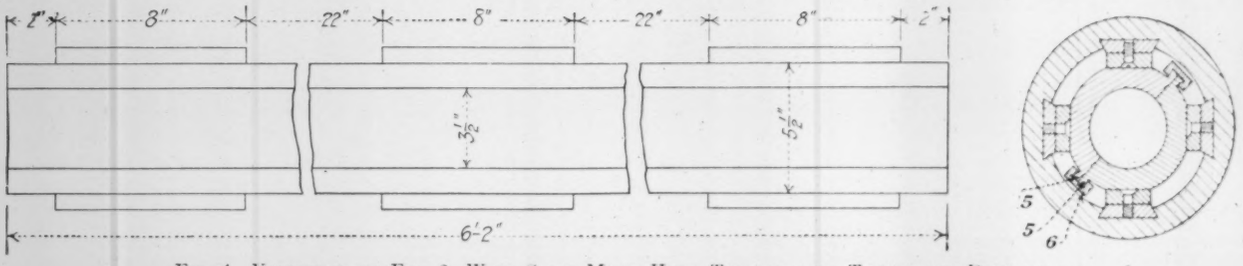

FIG. 4 VARIATION OF FIG. 2, WITH SPLIT MOLD HELD TOGETHER BY TAPERS AND DOVETAILS

operation of a split mold held together by bolts would be extremely dangerous.

To meet this condition the mold shown in Fig. 4 has been developed. This mold has side lugs machined in such a manner that when the two parts are put together a tapered structure, such as 6, is obtained, and dovetail pieces 5 are provided to engage with the taper 6. It is obvious that when the dovetail piece 5 is driven hard over the lug taper 6, it will hold it tight. Furthermore, both the lugs and the dovetails can be made within reason practically as heavy as desired, so that a good factor of safety can be provided to take care of bursting stresses in the mold. To close or open the mold it is only necessary to apply pressure to the dovetail piece or give a light blow, and by means of a simple jig the blow or pressure can be applied to all the dovetail pieces on the mold at once.

It is obvious, however, that the presence of the lugs makes the machining of the mold to a true cylinder expensive, if not impossible. Because of this, instead of machining the mold to a cylinder, a number, such as four, of flat faces are planed on the mold, the location of the faces being such that they will be distributed symmetrically around the longitudinal axis of the mold and that they will be tangent to a circle described with the point on the axis of the mold as a center. Such an arrangement is comparatively easy to carry out and it gives an excellent support for the mold, besides providing a structure with good dynamic-balance properties.

As regards the foundations and bearings for centrifugal-casting machines no special design need be described here, but it should be most clearly and strongly emphasized that both the bearings and the foundations should be of very generous proportions and most substantial design. The machine in centrifugal casting is subject to quite violent strains and unless it is properly built it is apt to get into vibrations which sooner or later may have a dangerous effect.

Up to about two years ago very little work, as far as the author knows, had been done successfully on the problem of casting centrifugally comparatively thin sections, say, under $^3/_8$ in., in such metals as steels or monel metal and in lengths of over 3 ft. On the other hand, large castings in brass, bronze, cast iron and even steel have been made with considerable success. The reason for this lies in the failure to understand the thermal conditions in the mold and the process underlying the freezing of the metal.

There is a basic difference between casting in a stationary mold and in a spinning mold. In making castings in the former, whether it be a simple ingot or a complicated casting from a pattern, the foundryman has means to provide for the escape of gas from the metal and for taking care of the cavities produced by contraction in cooling. In a casting from a pattern, sink heads are provided, while in an ingot casting the top of the ingot acts as a sink head, in addition to which special methods such as "dozzling" may be used to keep the top of the ingot hot as long as possible, and increase the efficiency of the ingot top in performing the functions of the sink head in molds. In both cases the foundryman is prepared to discard as defective a certain part of the casting (the ingot head, risers, sink heads) and his skill lies partly in reducing the quantity of discard as far as possible and especially in directing the process so as to restrict the presence of defective metal to the parts which he is prepared to discard.

In centrifugal casting, however, there is no riser or anything corresponding to the ingot top, and the cooling proceeds essentially at a uniform rate all along the length of the tubular shape. It is obvious, especially in tubes of small diameter and considerable length, such as 6 in. outside diameter and 16 ft. long, that the loss of heat inward must be extremely small, because the entire inner air cylinder is surrounded by metal at approximately the same temperature. Heat is therefore lost mainly outward to the mold and through it to the air. As a result of this, the part of the casting in immediate contact with the mold chills first. The problems with which the "centrifugal" foundryman has to deal are essentially the same as those which confront the man pouring into stationary molds, and these are, first, to get rid of the occluded gases, and, second, to take care of contraction cavities. As regards occluded gases and slags, it would appear at first sight, especially to those familiar with such centrifugal processes as cream separation, that they would be eliminated automatically; pure metal, being heavier than either slag or metal containing gases, should be thrown to the outside, against the wall of the mold, while all impurities should go to the inner wall. This does actually happen, provided one condition is satisfied, and that is that sufficient time is available; and it should be remembered in this connection that this separation takes place at a fairly slow rate because of the great viscosity of molten steel.

The second problem is that of cavities formed in the casting as a result of contraction in cooling. As stated above, the part of the casting in immediate contact with the mold chills first. In doing so it contracts, and if left to itself might easily form contraction cavities and thin spots. If, however, the rest of the metal is still in a liquid state, it is projected, with a pressure at the rate

of, say, 100 lb. per lb. of metal, against the chilled layer, and fills all possible cavities with an efficiency many times greater than can be obtained with sink heads in stationary casting. (To obtain the same results in a stationary mold, it would have been necessary to put into the sink head 99 lb. of metal for every pound of metal in the actual casting, a proposition that is not likely to appeal to a sane foundryman.) This again presupposes, however, that the cooling proceeds at a fairly slow rate, and enough time is available for each succeeding layer to take care of chill conditions in the preceding layer. In cold-mold centrifugal casting, which means with a mold warmed only enough to take off the chill, say, 300 to 400 deg. fahr., temperature conditions do not favor slow cooling, which is one of the reasons of the many past failures to produce thin-walled steel tubing by centrifugal casting. On the other hand, very excellent steel tubes (both plain carbon and nickel alloy) have been produced with diameters ranging from 10 in. up and wall thicknesses up to $3^1/_2$ in. In the latter case there is so much metal in comparison with the area in contact with the mold that enough time is available to produce a good segregation of impurities inward before the inner wall freezes.

It would appear, therefore, that the secret of producing centrifugally thin metal castings (under $^1/_2$ in.) lies in establishing conditions under which the cooling of the molten metal will proceed at a fairly slow rate. This applies, of course, only to such metals as steels and monel metal, but not to bronze, which is governed by different conditions. In the Cammen process this has been accomplished by preheating the mold to a temperature close to the melting point of the metal itself, which may vary from, say, 1600 to 2000 deg. fahr. for steel and monel-metal castings. Under these conditions a $^3/_{16}$-in. wall takes about 45 to 60 sec. to harden completely, which is sufficient to produce clean metal. Casting in such extremely hot molds is a rather novel procedure and at first one might anticipate trouble due to oxidation and warping of the molds and the difficulty of handling large molds conveniently. As a matter of fact, however, with proper equipment it offers comparatively few difficulties. The question of oxidation of molds is taken care of by using proper alloys, such as alloys of a nickel-chrome base or cast tungsten (the latter, however, not yet being used on a commercial scale). The question of warping is partly taken care of by the same use of proper alloys, but mainly by the use of extremely substantial molds and proper facilities for handling them between the casting machine, the transfer table and the furnace. In all this handling, the molds have to be properly supported throughout the entire length, either by carrying them on a very heavy "horn" extending from one end of the mold to the other, or in a cradle supporting the mold throughout its length.

The method of operation is as follows: The mold with its casting inside, both at a temperature well above white heat, are rapidly pulled out from the casting machine and carried over to what is known as a transfer table, where the casting is pushed out of the mold by a hydraulic plunger. While the casting is going to the proper rolls or benches, the mold itself is coated inside by a protective layer and carried over to a reheating furnace. The furnaces used in this connection do not differ essentially from the billet-heating furnaces in tube mills. The mold coating is intended to protect the metal of the mold from coming into direct contact with the molten metal of the casting and need not be more than, say, $^1/_{64}$ to $^1/_{32}$ in. thick. It consists of some refractory material like alumina, zirconia, kaolin, electrically calcined magnesia, or the like. Either pitch with some addition of solvent naphtha or clay may be used as a binder, the former being preferable as it contains no water. The coating may be applied either by a swab or through a compressed-air gun.

FIELD OF APPLICATION OF HOT-MOLD CENTRIFUGAL CASTING

The particular feature that determines the field of application of hot-mold centrifugal casting is the ability to produce cast shapes of comparatively thin metal (down to $^1/_8$ in.) in great lengths—with our present knowledge of the art, up to 20 ft. One of the first applications that comes to mind is in the production of seamless tubing.

Hitherto the principal tonnage of seamless tubing has been made by the Mannesmann piercing process and its variations. Essentially this process consists in imparting such a twisting motion to a steel billet as to break down its central fibers. This motion is set up by means of obliquely placed rolls or disks. There are several objections to this process. In the first place, while it does pierce high-grade mild steel or muntz-metal billets, it stresses the central part of the billet far beyond its elastic limit. While apparently this does not affect very seriously the tensile strength of the finished product after it has been cold-drawn or hot-rolled, there is good reason to believe that it impairs the resistance of the metal to corrosion, the latter, as we know now, being particularly active in the case of metals stressed up to or beyond the elastic limit. Furthermore, the Mannesmann process is not at all applicable to metals which are either extremely tough or very brittle. Thus, all attempts to produce commercially by the Mannesmann process, hollow billets of either monel metal or Admiralty brass have so far failed. Not only that, but the Mannesmann process, by its very character, is limited to the production of comparatively small sizes, not in excess of 6 in. in diameter, as the cost of a Mannesmann mill becomes prohibitive after passing that limit.

At the same time there is a demand for larger sizes of tubing of greater strength than a single-welded joint can give, and this is where the most obvious field of hot-mold centrifugal casting appears. With this process, tubing in extra heavy and double extra heavy thicknesses can be easily produced in sizes up to 24 in. in diameter at a cost per ton that can compete with plain welded tubing, and considerably lower than that of double-welded tubing such as is used for hydroelectric installations.

The next field of application in connection with steel tubing is in standard sizes from 6 to 14 in. up, where welded tubing is now used exclusively. Such pipe can be produced in two ways: First, by casting a hollow billet of wall thickness two to three times that of the finished pipe, and either cold-drawing or hot-rolling it to size. In such a case the billets cast would be roughly 8 to 10 ft. long so as to have, say, 22 ft. in the finished pipe, barring cropped ends. The other method is to cast the pipe direct with only a slight excess of wall thickness and then to give it one pass between straightening rolls over a ball, so as to reduce the diameter and wall thickness to exact size with standard tolerances, and give the exterior and interior walls a finished appearance. From data now available it would appear that the final cost of both kinds is approximately the same and is well within the range at which centrifugally cast steel pipe can compete in price with welded pipe. There is at least 50 per cent less handling of material in centrifugal casting than there is in making pipe by welding, and such a difference cannot help being reflected in costs.

In this connection it might be well to mention one of the psychological factors with which centrifugal casting is concerned, and that is the not unfounded distrust of users of metal products toward castings, especially those in thin sections. Such castings cannot be produced commercially in a stationary mold, and steel castings in a stationary mold as made today generally are of such physical properties as to be usable only where they are not subject to complicated stresses and where an extremely high factor of safety can be provided. Wherever the stresses are high and especially uncertain and the factor of safety is not more than ample, no engineer today will use a casting but will insist on either a forging or a piece machined or hot-rolled.

This not unfounded distrust of castings is due to the fact that in either the sand casting or chill casting the temperature conditions in the metal are uncontrollable, with the result that one part of the metal may be entirely different in its physical properties, such as hardness and crystalline structure, from another, and there is no guarantee that two castings made under apparently the same conditions will be entirely alike. There is too much individuality in products cast in stationary molds to make them suitable for engineering requirements where a failure would be disastrous and where only moderate factors of safety may be employed. The situation is, however, entirely different with centrifugal castings, because there ample facilities are available, especially in hot-mold casting, to control the rate of cooling of the metal, and the nature of the process is such as to tend to give a uniform product, provided, of course, the process is carried out properly. From this point of view, one cannot help agreeing with an editorial in *The Iron Age* (Feb. 9, 1922), which states that "the successful operation of centrifugal-casting processes insures a product, no

matter of what composition, which is of a high grade. It is a realization of quality production in quantity, for rapid output is a marked characteristic. There is also the advantage of the elimination of sand and dirt. The condition of casting and cooling tends to produce a dense casting and one whose microstructure is different from the sand-cast products. Centrifugal force is substituted for sink heads as an insurance against unsoundness." This brief analysis states strikingly the difference between sand castings and centrifugal castings, and explains the reason why centrifugal castings may be used on a par with forged or hot- and cold-worked metal where sand castings would be too hazardous.

But the field of application of centrifugal casting, especially of the hot-mold type, does not stop with plain carbon steels. There are a number of alloy steels which it would be very desirable to have in tube form, such as stainless steel, high-speed tool steel, chrome-nickel-vanadium steel and the various "near-steels" which are iron alloys with a predominance of materials other than iron, such as heat-resisting alloys. Practically none of these materials will stand for piercing by the Mannesmann process, but cast with great ease into tubular shapes. In fact, even Hadfield manganese steel has been found to make, by centrifugal casting, excellent tubing, although it is very doubtful it has any commercial application outside of some very limited specialties.

Plate Manufacture

Centrifugal casting is peculiarly applicable to the manufacture of plates. Andrew Shanks, a British inventor of the middle of the 19th century, to whose pioneering work in the manufacture of cast-iron pipe reference has already been made, was also the earliest manufacturer of plate. His process was to cast a thin-walled pipe, cut it, and then by careful annealing and hammering, flatten it out. The process was kept secret and was successful commercially until rolled steel sheet was put on the market.

The use of a hot mold makes it possible, however, to secure comparatively thin-walled castings in large sizes. A process has been worked out, though not yet applied on a commercial scale, in which a cylindrical casting is made in such a manner that a longitudinal split about half an inch wide is produced. The split cylinder as it comes from the mold is sent first through a flattening jig where it is flattened out on its own heat, and then to rolls, of which there are at least two, one for sizing and the other for finishing. Under certain conditions more than one sizing roll may be required. The casting has to be cast oversize, the wall thickness being from 10 to 15 per cent greater than that of the finished plate. Thus, for example, $\frac{1}{4}$-in. plate would be cast in sizes 240 in. long, 20 in. in diameter and 0.265 in. wall thickness. It is expected that it can be brought down to a thickness of $\frac{1}{4}$ in. in one pass in the sizing rolls and that no reheating will be necessary.

This process is today only in its initial stages of development. It is attractive, however, as it does away with the ingot-casting work, soaking pits, blooming mill and a great share of the rolling equipment, permitting a conversion from molten metal to finished plate at a cost estimated at about $4 per ton.

Not only that, but it also makes quite attractive the manufacture of alloy-steel plates, in particular, of such materials as acid-resisting steels for use in chemical tanks and the like. These steels are very difficult to roll. The final product could stand the cost of the two or three passes necessary in centrifugal casting of plates, but not the many operations of the conventional methods of plate manufacture, the main item of expense being not the actual rolling but the complicated heat treatment absolutely imperative between the rolling operations. In fact, it would not be surprising if with prices of alloy-steel plates brought within reason, they would be used far more extensively than one would expect to find from present indications.

Other Applications of Centrifugal Casting

The casting of gears by centrifugal methods, in particular worm and herringbone gears, has been achieved with great success both in England and in America, especially in the latter country. As far as the author is aware, however, all such gears have been cast in non-ferrous metals and not in steel.

There is one more field of application of centrifugal casting, especially the hot-mold type, comparatively small today but which may become of material interest shortly, and that is the production of cylinders requiring extremely high strength. When the oxygen industry first called for cylinders that would safely withstand 2000 lb. pressure to the square inch, it looked like a big problem, but it was solved by progress in the cupping process. When, however, the Haber synthetic ammonia process demanded great pressures combined with considerable temperatures, special expensive tools had at first to be provided for machining the cylinders required from solid stock. The Claude ammonia process employs temperatures and pressures far exceeding those of Haber, and the experiments of Professor Bridgman of Harvard University and of others all point to the likelihood that before many more years have passed pressures of the order of 100,000, 200,000 and possibly even more pounds to the square inch will be used commercially.

At pressures between those used by Haber and Claude and those used by Professor Bridgman for containers of commercial size, carbon steels are but little suitable and the vessels required will have to be made from alloy steels. This may be done in two ways, either directly by centrifugal casting on a vertical axis which would give a vessel with closed bottom, or by the cupping process from alloy-steel plates, which, in their turn, would be made by centrifugal casting as already described. In this connection it may be of interest to mention that a high measure of success was achieved during the war by the Bethlehem Steel Company at Bethlehem, Pa., in casting air flasks for torpedoes centrifugally in a machine running on a vertical axis.

No attempt has been made in the foregoing discussion of the field of application of centrifugal casting to present anything like an exhaustive list. Instances have been merely cited in order to show the enormous field in which this process is now or may be employed.

The same applies largely to the description of the mechanics of the process, where likewise no attempt has been made to show the historical development of machinery for centrifugal casting or to give details of the actual apparatus. Such machinery, it should be emphasized, is and should be comparatively simple, for the process when properly worked out is the acme of simplicity. It should be clearly understood, however, that in centrifugal casting we are dealing with large rotating masses and with metal subjected in its molten state to the effect of great force. Furthermore, the distribution of the metal in the mold is effected primarily not by rigid material visibly distributed as in stationary casting, but by the action of invisible forces which do not come into operation until the moment when the metal is delivered to the mold.

Because of all this, and notwithstanding the great simplicity of the machinery and methods of centrifugal casting, it should be clearly remembered that even the slightest imperfection in the design or operation will immediately show up in the casting. Centrifugal casting is a process which is peculiarly impossible to be worked either by slipshod methods or on a shoestring, i.e., skimping on the quality of materials and on factors of safety in the design of machinery.

There is an old saying current among molders to the effect that a lie in sand will be shown up in the metal. The same applies with still greater force to centrifugal casting. The slightest mistake in the layout of the machinery or the use of poor materials in the machine, its bearings and foundations, will produce an uneven casting, result in excessively rapid wear of the molds, and at times may even cause disastrous accidents with danger to life. At the same time, with good engineering and the use of first-class materials, centrifugal casting may be carried on entirely by semi-skilled labor and still give products of unsurpassed excellence.

[Five appendices accompanying the complete paper are devoted respectively to (1) a bibliography of the subject; (2) what is believed to be a complete list of all patents on centrifugal casting issued since 1848 by the U. S. Patent Office; (3) mathematical considerations governing casting about a vertical and a horizontal axis and the axial forces acting on the liquid metal in a horizontal mold; (4) temperature control of the metal of the casting and of the mold; and (5) fluid-pressure, fly-wheel and thermal-expansion stresses in molds used in centrifugal casting machines.—Editor.]

Hydroelectric Power-Plant Design

By J. A. SIRNIT,[1] BIRMINGHAM, ALA.

The most logical and simplest way to maintain the full capacity of a hydraulic power plant during flood periods is to remove the high tail water from the discharge opening. This may be most successfully accomplished by a backwater suppressor utilizing the waste water, and the present paper is chiefly devoted to the development and application of this method.

Two testing models are described and the results presented, while the design of the draft-tube orifice is discussed at some length. Finally the plant of the Alabama Power Company at Mitchell Dam on the Coosa River in Alabama, where the Thurlow type of backwater suppressor was first conceived and applied, is described, details of its construction and equipment being included.

THERE are many power plants and possible sites for such plants where the supply of water is very irregular, and where, owing to the nature of the surrounding country, it is impossible to provide sufficient storage for the utilization of all the water flowing in the stream.

In many hydraulic power plants, now in operation or proposed, there is, or will be, a great loss of power annually, due to the fact that during flood conditions when water is being wasted over the spillway, the level of the water in the tail race at the outlets of the draft tubes leading from the turbines is raised, thus reducing the head on the turbines, and in turn their capacity and the output of the power plant. There are many notable examples of these conditions, and in some cases reduction in effective head on the turbines becomes so great at times as to completely shut down the power plant. The Hales Bar plant on the Tennessee River is an example of where these conditions occur during the spring floods.

In many cases of proposed developments, engineers have hesitated in recommending the carrying out of the development on account of backwater conditions in the tail race, which can be foreseen and predicted very closely. The proposed development at the Great Falls on the Potomac, which has been under discussion for many years, represents an example.

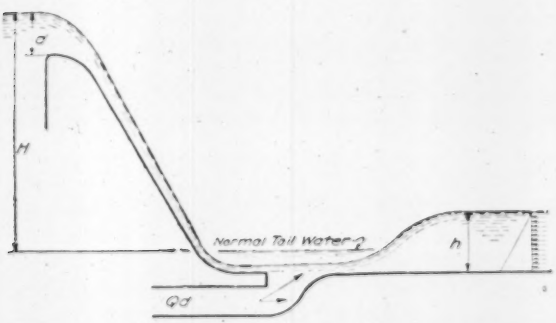

FIG. 1 ACTION OF SPILLWAY WATER ON TAIL WATER

(*H* = head above tail water; *d* = depth of water above spillway; *h* = total water column balanced; *Qd* = quantity through draft tube.)

Engineers for many years have wrestled with this problem and have tried to overcome this difficulty by installing a greater number of generating units where it was possible to do so, to compensate for the loss in capacity of each unit; of course such a procedure necessarily makes the installation more expensive, with the resulting increase of production costs. Attempts have also been made to counteract this loss in head by admitting water into the draft tube through jets at a relatively high velocity which, by accelerating the velocity of the combined turbine discharge and jet water through the draft tube, produce a negative head which is added to the head on the turbine. A number of variations in the place and manner of introducing this jet into the draft tube have been tried and results published. But the results have not been entirely satisfactory.

The most logical and simplest way to maintain the normal head on the water wheel, and thereby the full capacity of the plant, during flood periods, is to remove the high tail water from the discharge opening, and credit is due to O. G. Thurlow, chief engineer of the Alabama Power Company, who conceived the idea of utilizing the waste water to accomplish this fact, thereby successfully solving the problem. The development of this conception resulted in what is now known as the Thurlow backwater suppressor.

THE THURLOW BACKWATER SUPPRESSOR

It is a well-known phenomenon that water flowing over a masonry dam having a downstream face of ogee section, leaves the apron in a thin sheet at high velocity. At a point below the dam the water rises turbulently, forming a so-called "standing wave," "hydraulic jump," or "back roll." The thickness of this sheet and the velocity of the water depend upon the height and shape of the downstream face of the dam, upon the depth of water at the crest of the dam, and upon the quantity of water flowing over the dam. The energy developed in this thin sheet of water has generally been regarded heretofore as solely of a destructive nature, but in the backwater suppressor the energy of the spillway water is so directed as to remove the backwater from over the draft-tube orifice, sweeping it downstream, thus freeing the draft tube from this pressure of water over it and maintaining a practically uniform head on the turbine as long as the spillway water is able to sweep the backwater away from the draft-tube orifices. In Fig. 1 is shown diagrammatically the action of the overflow spillway water on the tail water. The energy of the spillway water not only removes the height of tail water from the draft-tube orifice, but even lowers the normal tail-water level to a predetermined depth.

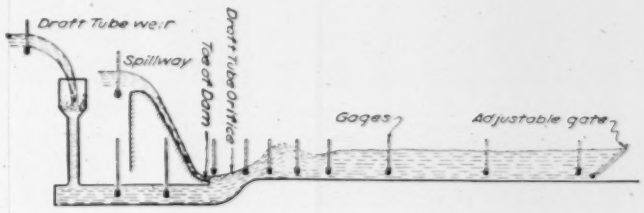

FIG. 2 DESIGN OF TESTING FLUME

MODELS TESTED

In order to substantiate the idea and evolve a definite theory on which to base the calculation, a model was constructed on a 1 : 24 scale at East Lake in Birmingham, Ala., where a small flow at 3 ft. head was available. The results obtained were so interesting that, to check the data obtained and to increase the accuracy of measurements, a second and larger model was constructed on a 1 : 10 scale at Jackson Shoals, Ala., where a greater flow and head were available.

The results obtained with the two models, when reduced to the same scale, were in close agreement and the observed results followed those calculated for similar conditions.

Fig. 2 shows diagrammatically the essential elements of these models. Each consists of a forebay for stilling the water, a spillway having the usual ogee section, a draft tube with its orifice located directly under the spillway, and a tail-water wasteway.

The heights of the water in the forebay, wasteway and draft tube were measured in glass gages conveniently located on central platforms. By means of these, measurements corresponding to the pond-level head above the river bed, the effective turbine head, the depth of water over the spillway, and the backwater head could be conveniently determined.

Weirs were used in admitting water to the draft tube so that the amount could be accurately measured. This amount was ordinarily maintained to correspond to a normal turbine discharge.

[1] Designing and Electrical Engineer, Alabama Power Co. Mem. Am. Soc.M.E.

Presented at the Spring Meeting, Atlanta, Ga., May 8 to 11, 1922, of THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS. Slightly abridged. All papers are subject to revision.

TABLE 1 SUPPRESSING PERFORMANCE OF JACKSON SHOALS MODEL

Water over river bed, in.	Head without suppressor, in.	Head with suppressor, in.	Water over river bed, in.	Head without suppressor, in.	Head with suppressor, in.
0	96	....	24½	71½	88
½	95½	96½	26	70	87
2½	95¼	95¾	27½	68½	80
19	77	96¾	29	67	73
20¼	75½	96½	29½	66½	74
21½	74½	97	30½	65½	73
22	74	96½	34	62	68½
22½	73¾	96¾	35½	60¾	66
22¾	73¼	96¾	40½	55½	66¾
23¾	72½	96½	46	50	56½
24½	71¾	89½	....	....	....

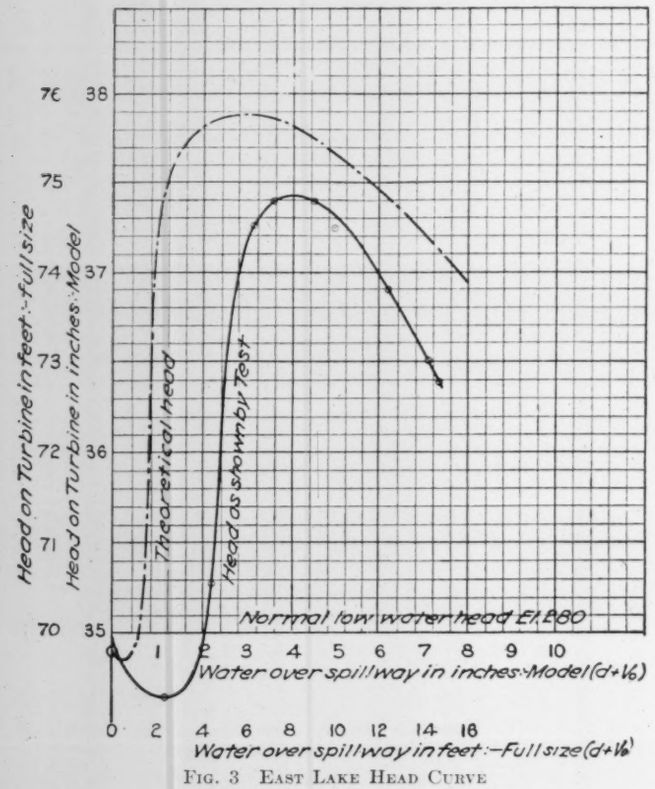
Head on Turbine in feet :- full size
Head on Turbine in inches :- Model
Theoretical head
Head as shown by Test
Normal low water head El 880
Water over spillway in inches :- Model (d+½)
Water over spillway in feet :- Full size (d+½)

FIG. 3 EAST LAKE HEAD CURVE

Bear-trap stop logs were provided at the end of the wasteway by which the height of the water in the wasteway could be varied to simulate backwater.

CALCULATED AND OBSERVED RESULTS

The height of the standing wave, taking a section of unit width (1 ft.) and neglecting losses due to the friction of the moving water over the spillway, can be approximated by the empirical formula $h = \sqrt{d^{3/2}H^{1/2}}$, in which d is depth of water in feet over the spillway and H the head in feet above the spillway apron. This does not take into account the effect of the turbine water. This factor will increase the height of standing wave, so that the actual results will be somewhat better than as shown by the formula.

The figures of Table 1 were compiled from three separate tests made at different times and show the performance of the Jackson Shoals model with 18 in. of water over the spillway in suppressing various heads of backwater.

The effect on the turbine head of different amounts of water over the spillway of the East Lake model is shown in Fig. 3. It should be noted that very small amounts cause a decrease in head because sufficient velocity has not been given to the draft-tube water to cause a thinning of the sheet over the draft-tube orifice, but when the ratio of spillway to draft-tube water increases to about 1 : 1 the curve takes a decided course upward and reaches its peak and starts falling off again due to a greater quantity of water passing over the orifice, with practically no increase in velocity above that of the point of maximum head. This curve does not represent the best performance possible but it is typical of the ideal theoretical curve which is shown in the same figure.

The curve in Fig. 4 shows the overall performance of the test as compared to that without the suppressor. It will be noticed that the head drops off slightly as the backwater increases, due to a greater quantity of water necessary to hold the standing wave, until a point is reached where the standing wave is 13.26 in. high and the curve turns sharply down. This point represents the critical stage or the maximum height of backwater capable of being suppressed by a given amount of spillway water. This could be increased by having a design of spillway permitting a greater discharge.

Even after this point is reached a substantial increase in head is obtained, and at the last point plotted, with backwater 50 per cent of the total head, an increase of 5 in. is recorded. Fig. 5 illustrates the condition of backwater after the critical stage has been passed.

DESIGN OF DRAFT-TUBE ORIFICE

Several shapes of draft-tube orifices were tested. That shown in Fig. 6 leaves very little to be improved upon for getting a maximum height of standing wave and a maximum head on turbine. This design can be modified to give a greater head on the turbine, but only at a sacrifice in the height of the standing wave.

The location of point x is of great importance as it controls the increase in head on turbine, and its relation to the elevation and angle of discharge of the spillway apron must be very exact or a poor performance will result; also consideration for the turbine "run-off" during the period when the suppressor is not in action must be kept in mind.

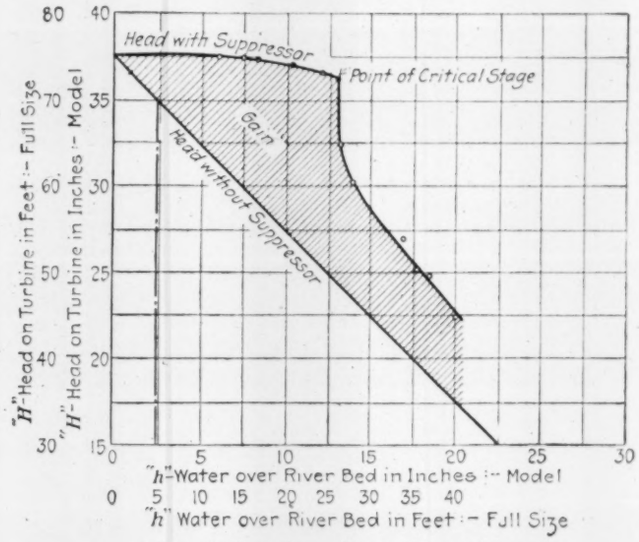
Head with Suppressor
Point of Critical Stage
Gain
Head without Suppressor
"H" Head on Turbine in Feet :- Full Size
"H" Head on Turbine in Inches :- Model
"h" Water over River Bed in Inches :- Model
"h" Water over River Bed in Feet :- Full Size

FIG. 4 EAST LAKE PERFORMANCE CURVE

The length of tangent t must be such that it will direct the spillway water well along the line ab, and it should be at least 5 ft. for heads up to 25 ft. and 7 ft. to 10 ft. for heads varying from 30 to 100 ft. The amount of water flowing over the spillway will cause this length to change, but for depths up to 15 ft. this range will hold good.

The distance out of point x is determined by the amount of water passing through the draft tube. The area of the draft-tube orifice subject to the action of the sheet of spillway water must be proportioned so that a back pressure in the draft tube is not necessary to force the two waters to mix. The curve of R_3 is great enough so that the centrifugal force of the fast-moving sheet of water will not cause it to leap clear of the concrete surface. R_2 makes a smooth transition, connecting point x and R_3, and is about $\frac{1}{2} R_3$.

The standing wave is held out just beyond tangent R_3. The total distance from the lip of spillway apron to the point of wave must not be greater than good design of the other features will permit, as the friction of the high-velocity water diminishes the height of the standing wave, thereby causing a greater amount of waste water necessary to operate.

The river channel below tangent R_3 must be finished with neat concrete for a distance of four heights of the standing wave, in the case of heads up to 25 ft., and five to six heights for heads varying from 30 to 100 ft. This is necessary for good performance although a rough bed or water pocket can be used, but a great waste of water is required and heavy undercurrents, due to an imperfect standing wave, might scour the river bed badly or undermine the protecting apron.

This is of great importance if the rock strata are poor, as open seams will allow the high static pressure beyond the wave to be transmitted back under the protecting apron, causing an uplift. This uplift must be given attention, even when the apron is carried out to the desired point and provision made for its secure anchor.

Dividing Walls

Each unit must be provided with dividing walls to prevent the water from coming in on the sides and to allow any one unit to operate independently.

The correct height and length of these walls is determined by the backwater and discharge curves of the river at the location of the power house. Section

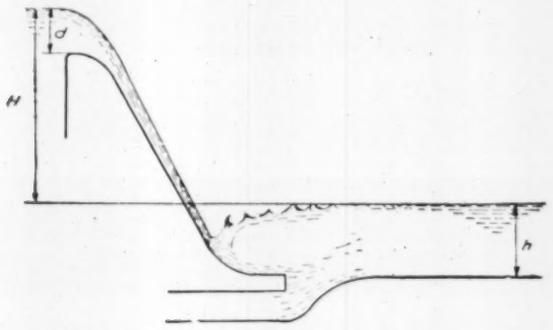

FIG. 5 FLOOD CONDITIONS OF MODEL

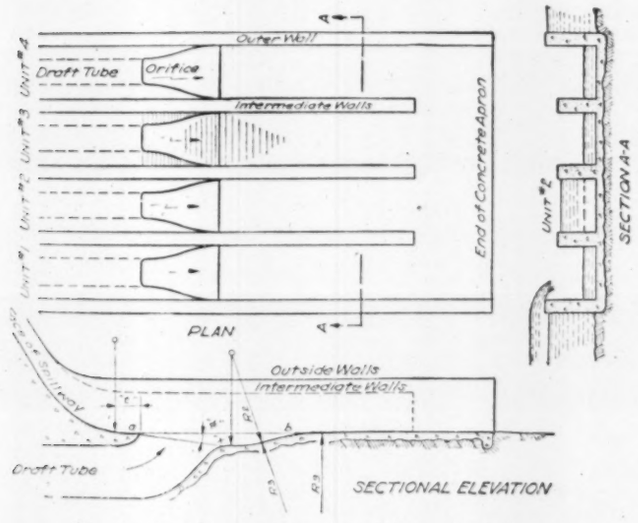

FIG. 6 AN EXCELLENT DESIGN OF DRAFT-TUBE ORIFICE

A-A, Fig. 6, shows the condition for the installation of four units. The three intermediate walls are at an elevation shown by the backwater curve when the required amount of water to operate four turbines and three suppressors is passing that point. When the fourth suppressor is brought into action the condition is as shown by the dotted line in unit No. 2, and these walls simply act as a guide to hold better conditions at the point of wave and prevent surging.

The two outer walls are designed for extreme flood conditions, as any water passing over the walls into the suppressor sheet will cause a loss in head on the turbine and in height of standing wave. However, if there should be spillway gates on both sides of the power-house section equal to the width of two units, it need not be at the maximum high-water elevation, but at the stage shown

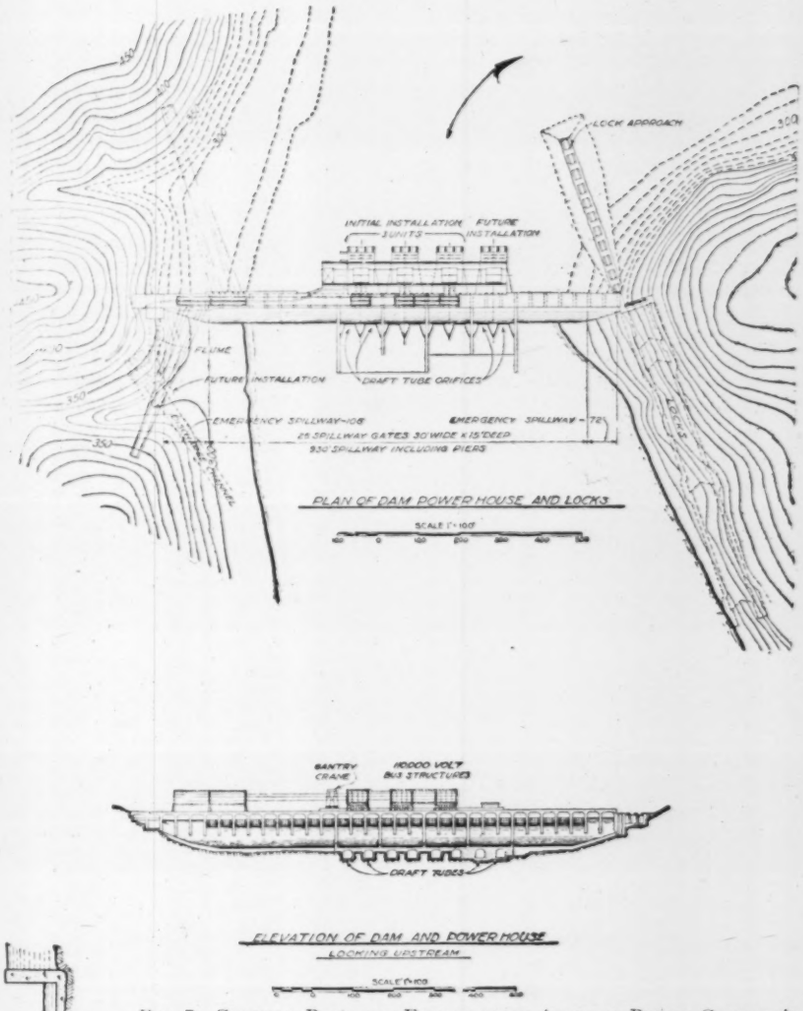

FIG. 7 GENERAL PLAN AND ELEVATION OF ALABAMA POWER COMPANY'S DAM AND POWER HOUSE ON THE COOSA RIVER

by the combined discharge passing the power house and side spillway. This is due to the fact that although a perfect standing wave is not formed at the toe of the side spillways, a lower elevation is created than will be further downstream, where the true backwater elevation is measured.

Power Plant with Backwater Suppressor

Encouraged by the splendid results of the model tests and the economic advantages of the undertaking disclosed by careful analysis, the Alabama Power Company decided to apply the backwater suppressor at Mitchell Dam on the Coosa River in Alabama, which is now under construction. The estimates showed that not only was the cost of the suppressor-type plant not higher than that of a conventional-type plant of equal output, but even lower in cost for the same number of units, and therefore for a given output the suppressor-type plant was considerably less expensive.

The principal and most outstanding feature in this plant is the location of the power units on separate foundations in the river on the upstream side of the dam (Fig. 7). Although this was not necessarily the only possible way to build the power house, it was the most economical. The river at this point being comparatively narrow, the entire length of the dam was required for spillway, and since the prime requisite of this type of plant is that the draft-tube discharge directly under the spillway section, the units had

to be so located that they would not obstruct any part of the spillway section.

The individual and separate power-house units offer the added advantage that trash racks do not present a solid front, which helps materially in cleaning them and affords an easy and convenient way of diverting the trash past the power house and over the spillway.

The usual power-house building is entirely eliminated. The generator room is covered with a low roof, which is designed in two sections, joined on the transverse line, mounted on rollers; each section moving in opposite direction. In normal operation the generator room is completely protected from the weather, but for handling large parts of the machinery, this roof can be opened and a crane utilized for performing the necessary work.

eration or even of breakdowns, due to the fact that operators have neglected the equipment to a lesser or greater degree.

The generators are so installed that the hot air from the generator is discharged into a separate compartment under the main floor and is expelled into the atmosphere through side openings of that room in summer time, thereby keeping the generator room reasonably cool. In winter, however, when heat in the rooms is desired, the outside openings can be closed and through registers in the floor the warm air enters the generator room.

The penstock does not represent a true scroll casing but rather a combination of scroll effect and open flume. The water velocities in the penstock being low, approximately 4 ft. per sec., this combination affords a better design.

The location of power-house units on the upstream face of the

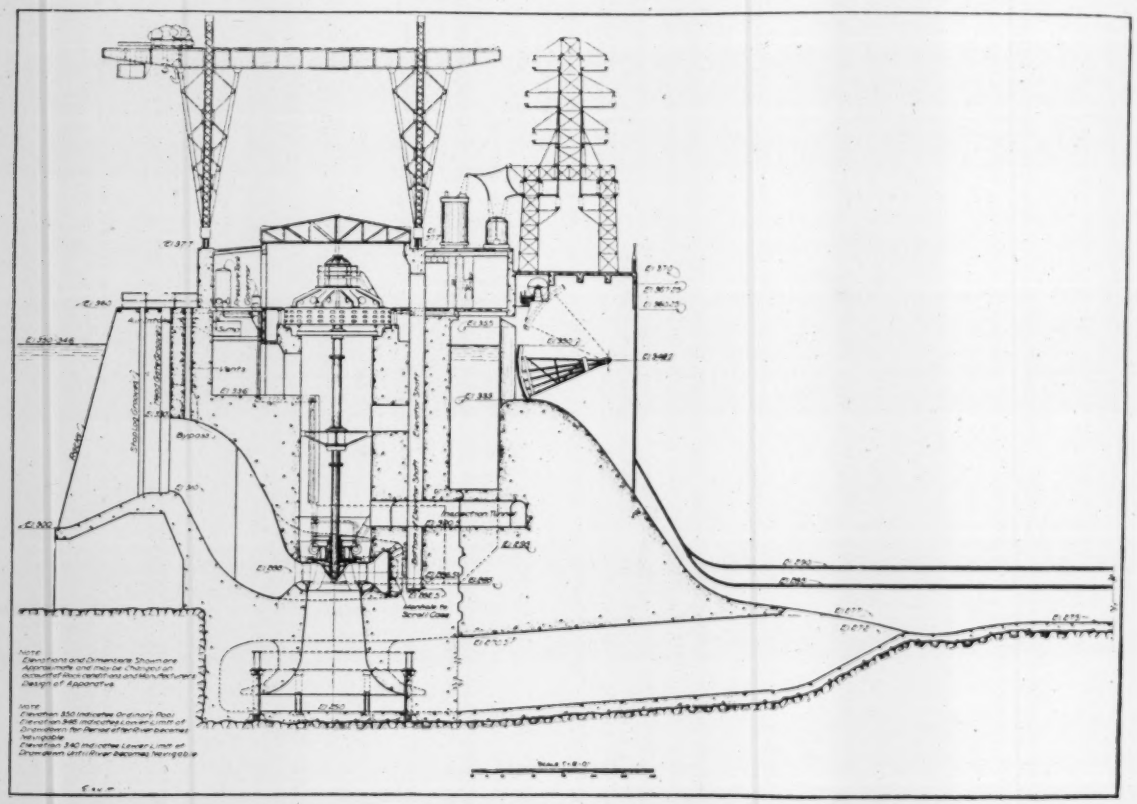

FIG. 8 CROSS-SECTIONAL ELEVATION VIEW OF THE POWER HOUSE SHOWN IN FIG. 7

A single gantry crane (Fig. 7) with full travel over the entire length of power-house section is so designed that everything, with the exception of spillway gates, can be handled by it. It is equipped with one 125-ton and one 20-ton hook, the former for handling heavy machinery and the latter for raising and lowering penstock gates, handling racks, stop logs and all other lighter parts.

An outdoor transformer and high-voltage switching station is located on the bridge over the spillway (Fig. 8). This plant is designed for operation on unit system, i.e., the generator and its bank of step-up transformers are connected as a unit and all principal switching is to be done with the high-voltage circuit breakers. In stations where units are of large capacity, as in the 20,000 kva. plant under discussion, the unit system is very economical and preferable, as it presents the simplest, yet sufficiently flexible, form of operation.

The entire operating floor is on one floor level. The generators, governors, switchboard, low-tension switches, bus galleries and offices are easily reached without climbing stairs or ladders. This materially adds to the convenience of operators and makes the supervision and inspection of the plant more effective. This feature of providing easy accessibility to all important parts of the station is very frequently lost sight of by power-house designers and the lack of these conveniences has been the cause of inefficient op-

dam lengthened the discharge tunnel to a distance of about 120 ft. from the center line of the unit. Although the velocity of the discharge is only 4 ft. per sec., the effect of this long column of moving water had to be carefully investigated and studied. This problem was solved satisfactorily by increasing the governor action to $3\frac{1}{2}$ sec. and setting the turbine to the lowest practical level. Turbine settings always should be as low as possible, especially where improved draft tubes are employed. Many of the troubles in existing power plants, such as pitting of runners, excessive vibration, etc., can be directly traced to high wheel settings, particularly with high-specific-speed runners.

Fig. 7 shows that 26 spillway gates of the Tainter type are provided, each 15 ft. high and 30 ft. wide. These gates are capable of passing the maximum flood water known to have existed in the past. There are also six bays, two on the east and four on the west end of the dam, which are designated as emergency spillway openings. The crest of these openings is level with the top of the spillway gates and their function is to provide additional spillway capacity in case of unprecedented floods when water would rise above normal pool level.

Although little has been said about the electrical equipment, it is one of the most important parts of the installation and should always receive close study and serious consideration if economical and efficient operation is expected.

The Boiler House of the American Sugar Refining Company at Baltimore, Maryland

By E. B. POWELL,[1] BOSTON, MASS.

TO AN industry such as the refining of sugar, the proper functioning of the boiler house is altogether vital. Almost every phase of every process in the refinery is directly dependent upon the application of steam as a heating or drying agent. For this reason, also, the cost of steam is an important factor in the manufacturing costs of the refinery.

In the design of the boiler house for The American Sugar Refining Company at Baltimore, the effort has been made to combine a high degree of dependability, efficiency and simplicity in operation and agreeable conditions of work, in a type of construction readily adaptable to the economic requirements of any permanent or long-term condition of fuel market, such as might call for the installation of economizers in any form, or the substitution of any other class of fuel than that initially selected.

The steam requirements estimated for the present developed capacity of the refinery were about 7,300 boiler-hp. average, and 8800 boiler-hp. maximum, demand. It was also considered that further developments might possibly increase the steam demands by about 50 per cent. The general suspension of refinery operations over Sunday would allow opportunity for any minor repairs that might be required in the steam-generating equipment, so obviating the necessity for much duplication in reserve, and permitting the economic adoption of moderately large units even for the initial development. On these bases, 6000 rated boiler hp. in 1200 hp. units was decided upon as the most suitable capacity to be installed for present requirements and 9600 rated hp. as the probable ultimate capacity of the boiler house.

A careful survey of the possibilities of all fuels considered commercially available led to the selection of a grade of small-sized anthracite, popularly known as "creek coal," as most satisfactory and economically meeting the requirements. This coal is not only low in price and, for practical purposes, entirely free from deterioration in storage but possesses as a fuel for the refinery boiler house the additional and important advantages of cleanliness—the refinery is turning out an essential food product of the highest quality—and of permitting the adoption of a single fuel for the entire plant—anthracite is required in the refinery processes for firing the bone-charcoal regenerating kilns. The major equipment of the boiler house, however, was designed for ready adaption to any type of fuel.

General Features of the Plant

Fig. 1 shows the refinery boiler house and outdoor coal plant as viewed from the Patapsco River, and Fig. 2 a representative cross-section. The building is of structural steel frame with brick walls and reinforced-concrete flooring, the basement being at the grade of the lot and the main operating floor about 28 ft. above. The structure is 111 ft. 5 in. wide by 132 ft. 10¾ in. in length with a height of about 125 ft. from the ground level to the top of the coal-bunker housing. The building footings rest on a continuous concrete mat foundation supported on wood piling closely spaced.

The main operating floor is practically clear of all equipment, except the boilers and stokers themselves. Liberal aisle space is provided to give convenient access at all points. Also, to minimize attendance, practically all the auxiliaries of the station are grouped together on the mezzanine and basement floors under the west line of boilers. The space under the east line of boilers is utilized for offices, toilet and locker rooms, laboratory, tool and storeroom, raw-sugar electric-truck charging station, and repair shop.

The boiler-house stacks are of reinforced concrete, 200 ft. high above the roof, 15 ft. in internal diameter, and supported on the building frame at the roof level. The coal bunker is of reinforced concrete, of the longitudinal type, set above the firing aisle and having a capacity of about 1200 tons, or three or four days' estimated normal requirement. To provide for ample daylight illumination, the bunker is raised somewhat higher than is usual and continuous skylights are set at either side, which admit a full flood of light into the boiler aisles.

The main coal storage is provided out of doors in the lot space bordering on the water front and to the east of the boiler house. Coal is normally delivered by rail to the B. & O. R.R. pier head, where it is discharged on to refinery-owned barges of about 700 to 800 tons capacity. The loaded barges are warped alongside the refinery coal wharf with the aid of electrically driven winches and are there unloaded, either directly to the station or to the yard storage, by means of an electrically operated movable tower of the through-boom type carrying a 2-yd. bucket of 150 tons' hourly capacity. The movable tower has a storage and reclaiming capacity of about 9,000 tons immediately beneath the boom; the remainder of the 25,000-ton outdoor storage capacity is served by locomotive crane.

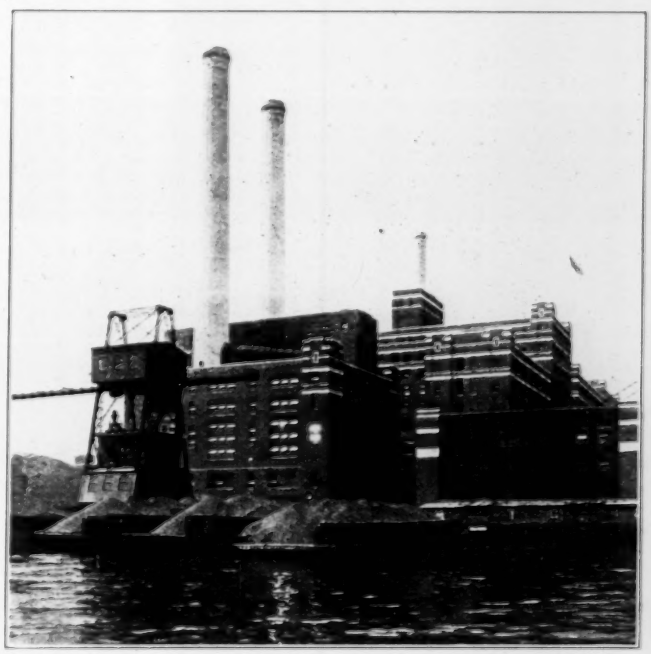

Fig. 1 The Boiler House of the American Sugar Refining Company at Baltimore, Md., as Viewed from the Patapsco River

Coal intended for the station bunker is delivered by the movable tower on to a 30-in. trunk-line belt conveyor which in turn delivers to the double-chain fixed-bucket-type elevating conveyor at the north end of the boiler house. From the latter conveyor it is distributed to the different sections of the bunker by means of a 24-in. belt conveyor and automatic tripper. From the bunker, coal is delivered to the stoker hoppers by an electrically operated automatic weighing larry. A separate pocket is provided in the boiler-house bunker for coal intended for use in the filter-house kilns; this coal is conveyed to the filter house by special overhead belt conveyor and weighed on automatic weightometer en route.

Steam leaves the boiler house and condensate, hot and cold water, and compressed air from the refinery reach the boiler house over a bridge near the northwest corner and at a level slightly above that of the mezzanine. The main steam header within the boiler house is in the form of a loop with one side carried above the east line of boilers, the other side accessibly located at the rear of the west line of boilers about three feet above the operating floor.

[1] Consulting Engineer, Stone & Webster. Mem. Am.Soc.M.E.

Paper presented at a joint meeting of the Baltimore, Md., Sections of the A.S.M.E. and A.I.E.E. and the Baltimore Engineers' Club, May 24, 1922. Slightly abridged.

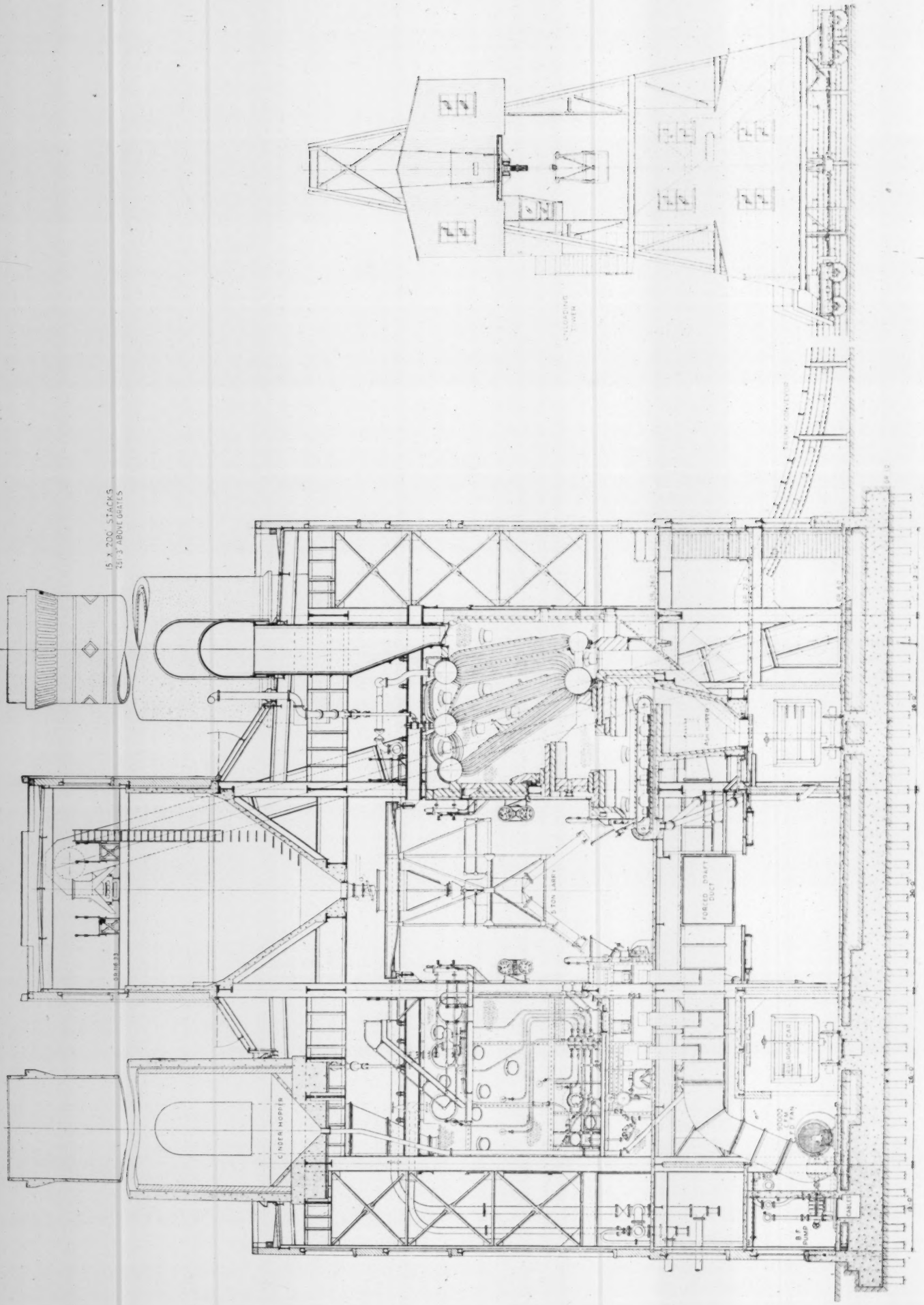

FIG. 2 TYPICAL CROSS-SECTION OF BOILER HOUSE

At the point of take-off for the two lines which lead respectively to the engine house and to the refinery, provision is made for opening the loop and feeding these two lines separately, with a regulating valve between set to maintain the desired pressure in the engine-room main. In normal operation, one of the division valves in the boiler-house loop will be closed to segregate to the engine-room main the boiler capacity required to carry the power load, the remainder of the boiler capacity on the line feeding through the other side of the loop to the direct-refinery main in which any pressure above 110 lb. will meet all requirements. With this arrangement sudden demands in the refinery can produce only negligible drop in pressure at the engine house, and such loss of pressure as may occur in the refinery main may readily be regained before there is any interference with manufacturing processes.

The Boilers

The boilers are in 1206-hp. units, Stirling type, with 26 per cent integral economizer surface and are encased in settings which, except for the rear wall back of the integral economizers, are of solid firebrick. There are no superheaters. The boilers are designed for 250 lb. pressure and will normally operate at about 210 lb. They are equipped with 18-element mechanical soot blowers and with automatic feedwater regulators. To avoid risk of corrosion the interior surfaces of all boiler drums and of economizer sections complete, both tubes and drums, are treated with a special carbon coating. This coating has been applied as a measure of extra precaution, as under normal conditions all air and other gases will have been removed from the boiler feed and there should be no tendency to corrosion in any form.

Flues and uptakes are of steel plate with 2 in. of inside insulation. Provision is made in the space above and at the rear of the boilers, including the space now occupied by uptakes, for the installation of additional economizer surface or of air heaters, should either prove desirable in future, and for cinder catchers, should the need for such apparatus appear.

The stokers are of the traveling grate type, two per boiler, with an effective surface for each stoker 9 ft. $8^5/_8$ in. in width by 16 ft. 4 in. in length, giving a ratio of grate surface to heating surface of 1 : 38. Each stoker is driven by a $2^1/_4$-3-hp. d.c. motor with hand-operated drum controller.

The ash hoppers are of reinforced concrete, brick-lined, providing capacity sufficient for about 16 hours' requirements and so set as to give ample clearance for the standard railway car of full gondola size beneath. The ash gates which form the bottoms of the hoppers are operated by air cylinders and designed to discharge directly into the railway cars.

All auxiliaries, except one feed pump for emergency and starting purposes, are electrically driven by d.c. motors. Four centrifugal feed pumps are installed in the west basement: two motor-driven of 750 gal. per min. capacity, and one motor-driven and one turbine-driven of 350 gal. per min. capacity. Forced draft is supplied by three turbovane-type fans of 90,000 cu. ft. per min. capacity at $5^1/_2$ in. pressure, driven by 125-hp. motors under automatic control from the steam-line pressure. These fan sets are located on the basement floor under the west line of boilers and draw the bulk of their air supply from the ash alleys. Adjustable louvres opening into the fan bays from the west mezzanine are, however, provided for ventilation. For cleaning purposes and for operation of ash gates, damper regulators, and other devices of a 200 c.f.m. motor-driven air compressor is provided which is located with other auxiliaries in the west basement. Reserve air supply is had by pipe connection with the compressor plant of the refinery.

The Feedwater System

As practically all steam leaving the boiler house, including that used for power purposes, is condensed in closed coils in the refinery and so normally available for boiler feed, the feedwater make-up requirements estimated are but slightly greater in percentage than those of the modern condensing-type electric generating station. To meet the accidental condition of evaporator-coil leakage, or other cause of contamination or loss of condensate, however, it has been necessary to make provision in the feedwater equipment for the emergency use of raw water exclusively.

Under normal conditions, condensate will be returned from the refinery at a temperature of between 180 and 220 deg. fahr.; the raw make-up water will normally reach the boiler house at city main temperature, about 50 to 70 deg. fahr. The condensate returned to the boiler house is first passed through standard toweling-type filters to remove any suspended impurities; from the filters it discharges into a 12,000-gal. receiving tank located on the west mezzanine. The normal make-up, direct from the city mains, is delivered first to a deaerator having a capacity of 24,000 lb. per hour and located above the receiving tank and on the west wall of the boiler house. In this apparatus practically all dissolved oxygen and other gases are removed. The deaerated water, so called, is delivered direct to the receiving tank under float control at about 190 deg. fahr. A 15,000-gal. storage tank equipped with float seal to prevent air contamination is set in the northwest tower of the boiler house to provide a reserve supply of deaerated water for boiler-filling purposes and to meet all except the most unusual or emergency demands. At times of low make-up requirement this storage tank will be filled. Its contents at all times are indicated by pneumercator gage conveniently located on the wall of the west mezzanine. The supply from this reserve storage is fed into the receiving tank automatically, as required, through a float-operated valve. Two emergency supplies are provided, one from the hot-

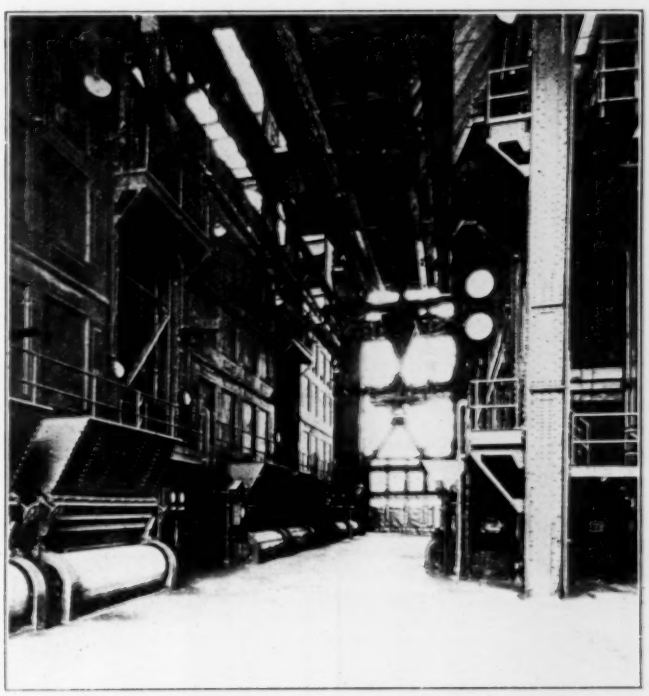

Fig. 3 The Firing Aisle

water system of the refinery, the other direct from the city mains, both under float control, the latter at the lower level. The emergency supply direct from the city mains is delivered to the receiving tank through a closed-type high-pressure heater. The opening of the float-controlled valve on this line caused the simultaneous opening of a motor-operated valve admitting steam to the emergency heater, after which, regulation of temperature is under thermostat control. When the float-operated valve closes off the emergency supply to the receiving tank it at the same time causes the motor-operated valve to cut off steam to the emergency heater.

Condensate from the high-pressure mains in the boiler house is taken care of by a Holly system, which of course returns this condensate direct to the boilers. Condensate from the low-pressure or exhaust mains in the boiler house is collected in traps which discharge directly into the return tank in the engine house and are returned to the receiving tank with other condensate through the oil filters.

Instruments

The more important instruments employed in gaging the boiler and furnace performance—two electric tachometers to indicate the grate speed of each stoker and a boiler meter recording steam out-

put, rate of air flow, and flue temperature—are mounted on a small slate panel at one side and immediately in front of the several boiler units. For guidance in adjustment of drafts, multi-reading draft gages are mounted, one at each side of the boiler in convenient view of the stoker blast-box damper levers and a third gage at the rear of the boilers beside the exit damper control.

Illuminated master gages, mounted at either side of the main operating aisle and about midway of the ultimate length of this aisle, indicate, on the one hand, the pressure carried in the two distributing mains leading from the boiler house to the engine house and direct to the refinery, respectively, and on the other, the rates of steam flow in these two mains. The steam flow through these mains is also recorded by meters which are mounted on a small slate panel beneath the corresponding master gages and of general design and position to harmonize with the boiler-meter panels referred to above. An illuminated number signal, operated from the vacuum-pan

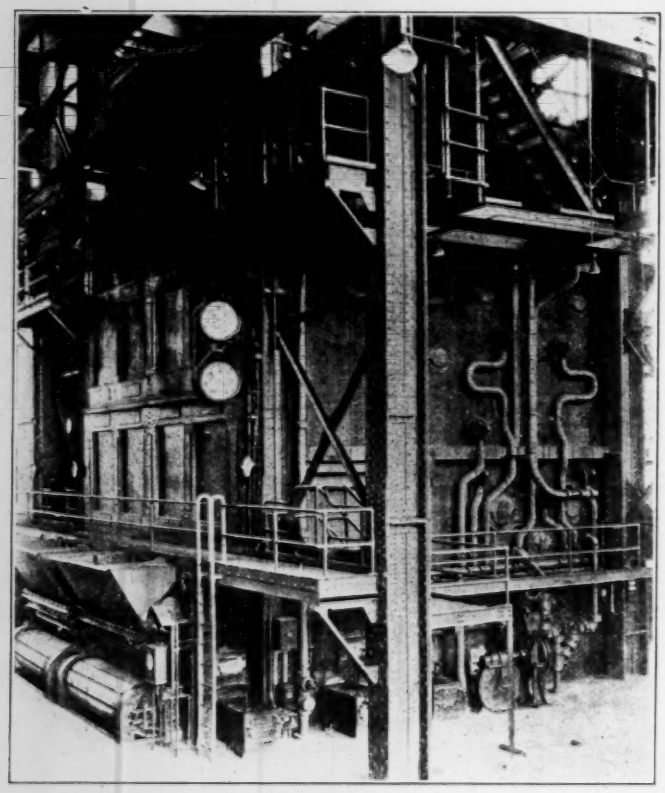

FIG. 4 ONE OF THE BOILER UNITS, SHOWING ARRANGEMENT OF ACCESSORY EQUIPMENT

floor in the refinery, gives the fireman advance warning of major changes in load. There are also numerous indicating and recording thermometers and gages which are required in following the performance of the feedwater system and other details of the boiler-house equipment.

SELECTION OF BOILERS

The refinery type of load, while including a fairly large proportion of power of reasonably stable demand is subject to relatively wide fluctuations which may come at any time of day as the vacuum pans are cut in or cut out. For this reason it is necessary to carry continuously in service sufficient steam-generating capacity to take care of the maximum demand, this steam-generating capacity on the average being operated at only moderate ratings. For this service the Stirling integral-economizer-type boiler was selected as combining, with low first cost, very high efficiency at all moderate ratings, exceptional ease of inspection and maintenance, and, with the steam take-off from the rear drum as here adopted, remarkable freedom from tendency to prime under sudden heavy demands. Also, for the peculiar requirements of anthracite in the small sizes decided upon for the Baltimore refinery, this general type of boiler possesses, over any other type of approximately equivalent efficiency, the added advantages of wider grate space and of presenting to the furnace gases steeply inclined tubes, which experience with anthracite has demonstrated are less liable to heavy coating and clogging of the heating surface from deposits of slag and ash than the tubes of boilers of the so-called "horizontal water-tube" type.

THE COMBUSTION EQUIPMENT

In determining upon the method of combustion, the traveling-grate stoker was decided upon as the most satisfactory type of combustion equipment commercially available for the particular coal selected. However, the plant design provides for later adaptation to pulverized-coal firing if desired.

One of the most serious difficulties, or more aptly perhaps, one of the most serious sources of loss, encountered in the use of very small-sized and so-called "creek" anthracite for boiler fuel has been the high percentage of the material that has remained unconsumed—either discharged over the end of the grate with the ash or carried by the gases beyond the zone of combustion to be deposited in some cooler part of the boiler, or over the surrounding neighborhood. One of the chief defects, seemingly inherent in the traveling-grate type of stoker, has been that of gas stratification, insufficient mixing of gases so that in the usual case, gases given off from that part of the fuel bed near the front, in other words, near the entrance of the furnace, carry a relatively high percentage of combustible constituents, as CO for example, with insufficient air for their combustion, while those gases from the rear of the grate carry an excess of unused air and oxygen.

Boiler furnaces in this country have, with two or three exceptions, been of box-like construction—for a traveling grate, two boxes connected together,—offering but little interference with simple streamline flow of the gases. With such an arrangement of furnace, operating beyond the most moderate ratings, the richer gases from the front of the grate rarely find the full air requirement until they have passed over a part of the heating surface so that combustion if not already extinguished must continue through the boiler, resulting in loss to efficiency and, occasionally in exaggerated cases, serious damage to the boiler plates and other parts not designed for direct contact with intense flame.

The arch arrangement used in the furnaces of the refinery boiler house, and shown in Fig. 2, is intended as a step toward overcoming these several sources of loss and inefficiency. The rear arch deflects the gas flow over the corresponding portion of the grate surface, from a generally rearward direction, toward the front of the furnace and by so doing checks the shower of fine unburned particles into the ashpit—a phenomenon characteristic of the combustion of small-sized anthracite in the usual type of furnace—and gives opportunity for the lean gases from the rear of the grate to combine with those from the front. The width of throat between front and rear arches is so proportioned that some degree of mixing of gases is forced to occur except at the very lowest ratings. The presence of the rear arch, by its radiating and reflective capacity, also tends to increase the rate of combustion at the rear of the grate and so further reduce the carbon loss to the ashpit.

As the rear arch is not only exposed to the most intense heat of the furnace, but also projects directly into the furnace at the hottest zone, it was considered necessary to provide forced ventilation. Air for this purpose is obtained direct from the blast duct, and after traversing the rear arch, passes forward through the side and center walls to be finally discharged into the furnace at the rear face of the lower front arch where it serves to aid combustion of the rich gases traveling close under the arch from the front of the furnace. The final mixing of gases occurs under the upper front arch which also forms a deflector to throw the gases into the boiler-heating surface. The intention has been that the mixing zone between the lower front and rear arches and the upper front arch by affording increased intensity of combustion at this point, would not only hasten combustion of evolved gases, but also promote combustion of those solid coal particles normally carried off the grate by the draft.

Preparations are now under way for complete tests of one of the boiler units. In connection with these tests it is intended to make thorough trial of the creek anthracite of several different degrees of fineness. The tests are planned to develop not only the relative commercial values to the refinery of these different coal sizings, but also the general characteristics of a furnace of the design shown.

The Utilization of Waste Heat

A Group of Papers Dealing with the Application and Performance of Waste-Heat Boilers, and the Utilization of Waste Heat from Blast and Open-Hearth Furnaces and Cement Kilns

GREAT progress has been made in recent years in the development of methods of utilizing waste heat, especially in the steel and cement industries, and serving a region in which these products are extensively manufactured, the Lehigh Valley Section of the A.S.M.E. appropriately devoted its meeting of October 11, 1921, held at Bethlehem, Pa., to a consideration of this growingly important subject. Three papers embodying much valuable information were presented, namely, Waste-Heat Boilers, by H. B. Smith of the Babcock & Wilcox Co., New York, N. Y.; Utilization of Waste Heat in the Steel Industry, by A. T. Lewis, of the Bethlehem Steel Co., Bethlehem Pa.; and The Utilization of Waste Heat from Rotary Cement Kilns, by Joseph Brobston, vice-president, Dexter Portland Cement Co., Nazareth, Pa. The texts of these papers, slightly abridged, immediately follow.

THE APPLICATION AND PERFORMANCE OF WASTE-HEAT BOILERS

By H. B. SMITH,[1] NEW YORK, N. Y.

SO MUCH has been written within the past few years on the theory of the modern design of boilers for the utilization of heat in the waste gases from various industrial furnaces that there is little or nothing new that can be added. The present paper, therefore, will deal wholly with the application and performance of waste-heat boilers.

The company with which the author is associated has at the present time installed and in operation in connection with the various types of industrial furnaces, waste-heat boilers of a total capacity of 153,499 rated boiler hp., distributed as follows:

Open-hearth furnaces	102,211	Glass tanks	1,716
Cement kilns	15,834	Copper-refining furnaces	1,347
Beehive coke ovens	11,730	Nickel furnaces	922
Zinc furnaces	8,740	Lime and dolomite furnaces	818
Heating furnaces (various types)	4,243	Malleable-iron furnaces	373
Oil stills	3,975	Silicate furnaces	232
Gas benches	1,328		

Generally speaking, three classes, or designs, of the Babcock & Wilcox boiler are ordinarily offered for waste-heat work, namely, 18-high, 3-pass boilers for such types of industrial furnaces as require a comparatively high draft for their operation, this draft varying from 1½ in. to 2½ in. water column; 24-high, 3-pass for furnaces requiring a draft of 1 in. water column or less; and 27-high, single-pass boilers where the draft requirements of the primary furnace are very low, and where such requirements and the frictional loss through the boiler can be met with a natural-draft stack. Further, such boilers are offered where a direct connection to the primary furnace is possible. The single-pass boiler, strictly speaking, is not of the modern waste-heat design, but it has its special field which will be discussed later.

The flues and valves connecting the furnace and the waste-heat boiler must be of such construction that the air infiltration and radiation may be kept at a minimum. As a rule very little difficulty is found with radiation losses, but the air infiltration in every plant is, without exception, a difficult problem. Of course, it is possible to install a fan and fan turbine of sufficient size and capacity to overcome all of the air infiltration, but if this is done the net steam output of the installation may be reduced to such a point that the return when figured in dollars and cents will not warrant the investment.

Draft and the resistance of the gases passing through a boiler are two of the important factors in waste-heat-installation design. The draft loss is a function of two factors, the loss due to frictional resistance and the loss due to the passage of gases over and under the baffles. In order to obtain the greatest net amount of steam from the boiler, the draft required at the entrance to the boiler and the draft loss through the boiler should be so proportioned that when a steam turbine of minimum water rate for this class of machine is used to drive the fan, the exhaust steam from this turbine will not be greater than can be absorbed by the water in heating all the water consumed by the boiler to 210 deg. fahr. With such an arrangement there is a thermal loss which, when expressed in boiler horsepower, will be approximately 2 per cent of that generated by the boiler.

Whether or not an electric motor should be used in place of a steam turbine for the fan drive is a question that must necessarily be solved in each individual case. The items involved in such a question are the amount of hot water or the exhaust steam available for heating the water, the economy of the electric generator, and the reliability of the electric service. In regard to the latter, it would not be good engineering to equip, say, eight or ten open-hearth furnaces with waste-heat boilers, the fan drive for which is an electric motor, and not be doubly sure that the current would not be interrupted from time to time.

Failures Due to Lack of Attention

"Because of the war" is an expression much used when citing causes for trouble and sometimes failure, and to this same cause can be attributed in a large measure the failure of some of the users of waste-heat boilers to give proper attention to the upkeep of their installations. This failure has come through the customer's abnormal drive for output which has affected not only the waste-heat-boiler installations but the apparatus of the entire industrial plant as well. Another thing which has contributed to the inadequate attention has been the more or less unreliability of the labor obtainable.

As an illustration of the result of lack of attention given waste-heat installations, there were installed in a steel mill in 1917 a number of waste-heat boilers in connection with open-hearth furnaces. In May of the following year after the boilers had been operated some four months, evaporative tests were run to determine for the customer just what he was obtaining in boiler capacity. The tests showed an average of 445 hp. per hour from a 75-ton furnace, or an average of 70 boiler hp. per ton of steel per hour. At the coal and labor costs existing at the time, a horsepower was worth in this plant approximately $110 a year, showing a return of $49,000 a year per furnace, or at least 50 per cent return on the investment. But little was heard from this plant until less than a year ago, when a complaint was received from the customer that the boilers had fallen off in efficiency to such an extent that they were only attaining 250 boiler hp. per hour, which was a reduction of over 40 per cent. Coal and labor costs existing in the plant at the time of the complaint as compared with those of 1917 were not available, but the loss resulting from the reduced capacity is obviously great. The complaint was investigated and conditions were found such that an engineer was placed in the plant to thoroughly overhaul one of these boilers and put it in good operating condition. This work required five weeks with a gang of three to five men. From this one can appreciate the extent to which the installation had been neglected and realize the tremendous loss which resulted from neglect to properly care for the boilers.

Upkeep Costs Low

There is every reason to believe that the upkeep cost of waste-heat installations are very low, for, taking them as a whole, it will be agreed that because of the low-temperature gases which are encountered the tube losses from blisters will be rendered practically negligible, if not impossible. These low-temperature gases also result in a minimum brick deterioration, and in practically all cases the brick replacement cost should also be negligible. The only class of waste-heat work where brickwork upkeep cost need be considered is in the open-hearth field. While there are systems

[1] Babcock & Wilcox Co. Mem. Am.Soc.M.E.

of reversing valves which entirely eliminate the possibility of explosions in open-hearth waste-heat work, the use of such systems is not general, and with the valve reversing systems in common use it is practically impossible to prevent an occasional explosion. These explosions vary in intensity and have under certain conditions been sufficiently severe to blow out the side boiler wall, and in one instance to break off the header doors from the hinges.

TYPES OF BOILERS USED IN STEEL WORKS

The simplest form of Babcock & Wilcox waste-heat boiler offered is of the single-pass short-tube type, usually 9 to 11 ft. in length and 27 tubes high with a stack located on top of the boiler setting. This type of boiler is particularly applicable to furnaces requiring a low draft for operation and high gas temperatures as the gases leave the furnace. By high gas temperature is meant a temperature considerably in excess of that encountered in open-hearth and cement work, yet below that encountered in coal- and oil-fired furnaces. It does not follow, however, that such a boiler could not be used with temperatures from 2500 to 3000 deg. fahr., for with these temperatures and the very low draft required the boiler would show a high efficiency. As a matter of fact, the higher the temperature of the gases entering the boiler, the higher will be the efficiency of this boiler.

The arrangement of heating surface is such that there is a very low draft resistance, and further, this arrangement is such that the boiler in itself serves as a stack. In other words, if there were no stack located on top of the boiler setting there would be a draft of from probably 0.05 in. to 0.1 in. in the furnace from this boiler with gases entering it at 1800 deg. or above.

This type of boiler was developed many years ago for waste-heat purposes and a large number of them were installed. It was looked upon as an efficient boiler for the purpose for which it was designed, but the change in operating conditions, in the furnaces, etc., to which it was attached, caused it to become less satisfactory and for quite a considerable period practically it was not used. During the past few years, however, several installations have been made under proper conditions which have resulted most satisfactorily and in very economical installations.

The following figures which are taken from a test conducted at a plant in Pittsburgh where the old type of puddling furnace is still in use, show what may be expected from a boiler of this design installed where conditions are suitable for the single pass. The boiler tested was a 7-wide, 27-high, 9-in. tubes, having a total heating surface of 1880 sq. ft. There was a stack on top of the setting 75 ft. by 36 in. The boiler was operated at 122 lb. pressure and developed 220 hp., which, it will be noted, is slightly over rating. The temperature of the escaping gases was 501 deg. and the amount of coal fired (moisture content 2.33 per cent) was 857 lb. per hour. The evaporation per pound of dry coal was 9.09 lb. of water from and at 212 deg. This is equivalent to 3.85 lb. of coal per boiler hp. and an efficiency of 64 per cent. The results obtained were therefore but slightly lower than those representing good practice in hand-fired power houses.

The typical Babcock & Wilcox waste-heat boiler for open-hearth furnace work is an 18-high cross-drum, usually with 16-ft. tubes, the gases being delivered to the fan through the horizontal circulating tubes. The fan, gears, and turbine are supported on a platform above the boiler carried on the boiler columns.

The majority of installations with open-hearth furnaces have been in mills already in operation, and oftentimes it has been no little problem to find a space large enough to install a boiler of the proper heating surface. The sectional design of the B. & W. boiler, however, has been of immeasurable advantage in such cases, for with this it is possible to modify the width, length, and sometimes the height to accomodate the local space conditions and thereby provide a sufficient and efficient heating surface.

The returns from such installations have been most gratifying. Not only has there been a return in steam sufficient to pay a handsome return on the investment, but in many of the plants there has been an increase of two heats a week from the open-hearth furnaces and this was accompanied, as one would expect, by an appreciable reduction in the coal per ton of steel. This reduction follows from a positive draft control.

Figures given during the war indicated a saving due to the installation of waste-heat boilers on open-hearth furnaces of from 25 to 30 cents per ton of steel produced. On the basis of 25 cents a ton, 50-ton heats, and 14 heats a week for 45 weeks, the annual saving would amount to $8400, while for a 100-ton furnace it would be $16,800. With a 100-ton furnace there would be offered a boiler of 550 hp., which at the period mentioned could be installed complete for approximately $50 per hp., or $27,500. On such a basis the installation would pay for itself well within two years. While the saving expressed in cents per ton of steel may not be as high today as the wartime saving given, nevertheless the ratio of saving to boiler cost would be approximately the same, since boiler costs closely follow steel costs.

In a certain waste-heat boiler installed over a reheating furnace at the Bethlehem Steel Works the gases and steel pass in opposite directions through the furnace and the former enter the boiler immediately above the gas-discharge end of the furnace. This boiler is 19-wide, 17-high, with 16-ft. tubes and 48-in. cross-drum, having 5830 sq. ft. of heating surface. Tests on this unit showed an average output of 540 hp. per hour with an entering gas temperature of 1445 deg. fahr., the gas exit temperature being 545 deg. The draft loss was approximately 1 in. water column. To overcome this loss and furnish sufficient draft for the proper operation of the furnace required approximately 8 boiler hp., or less than two per cent of the total generated by the boiler. Unfortunately, during these tests sufficient data were not obtained to show the relation of power developed to the steel reheated or the fuel consumed.

In a representative arrangement such as would be made with a malleable-iron furnace the boiler employed is 24-high, 3-pass, with longitudinal drums, the draft apparatus being located on a platform carried on the boiler columns. The unit is equipped with an auxiliary hand-fired furnace, which makes possible steam generation during such times as the malleable-iron furnace may be shut down. It is possible, however, to operate the boiler on both waste gases and gases from the hand-fired furnace, due to the fact that the draft required to operate the malleable furnace is about the same as that which would be required for hand firing.

INSTALLATIONS IN CEMENT MILLS

In 1915 a 1530-hp. Babcock & Wilcox boiler was installed for the Louisville Cement Company, this company being really the pioneer in the use of the modern design of waste-heat boiler in connection with cement kilns. Regarding the operation of this boiler, H. D. Baylor, superintendent of the company, in a paper presented before the American Institute of Chemical Engineers in June, 1917, said:

> Our coal consumption in the boiler room for 1914 averaged 91.7 lb. per barrel of cement. The waste-heat boiler was put into service during May, 1915, with the result that our average coal consumption for 1915 was 57.6 lb. per barrel of cement. During 1916 the boiler was operated practically full time and our average fuel in the boiler room for the year was 40.2 lb. per barrel.
>
> By using the hot clinker to heat the air for combustion and the waste kiln gases to generate steam, our percentage of heat utilized has almost doubled, showing 67.2 per cent fuel efficiency in the combined system of kilns and waste-heat boiler, and this we hope to increase to 70 per cent by reclaiming a part of the heat now lost by radiation from the kiln shell; and it is but another step to reclaim a part of the heat now escaping from the stack of the waste-heat boiler; or in other words, our combustion efficiency will eventually compare very favorably with general boiler-room efficiency.

In one more or less standard arrangement of waste-heat boilers, economizers, fans, collecting and connecting flues for cement-kiln work there is a common flue located transversely to the kilns into which they deliver the gases. On the opposite side of this flue the boilers are located, the gases passing through the short connecting flues. Between the kilns and the collecting flues as well as between the collecting flue and the boilers, water-cooled dampers are provided. The bottom of the flue is in reality a series of hoppers for depositing and handling the dust precipitated from the gases. These hoppers are provided with a slide valve and chute for discharging the dust to screw conveyors located beneath the main flue. The boilers, economizers and all short connecting flues are also provided with hoppers similarly equipped with slide valves and chutes. Ordinarily the main flue and all connecting flues are made of steel plate lined with insulating material and firebrick.

An arrangement of this kind lends itself to flexibility in that any boiler or kilns may be taken off without interruption of the

plant output, since the boilers are so designed, when there are three or more, that one boiler may be taken out of service and the remaining boilers handle all of the gases. When an installation of only two boilers is made it is not practicable, from the standpoint of cost, to have each unit of sufficient size to handle the total weight of gas, should it be necessary to take one unit off the line. A two-unit installation is therefore not as flexible as one with a greater number of boilers, and with one unit down, the remaining unit, while capable of handling more than half the total gas, would probably not handle more than 75 per cent of the total, necessitating the by-passing of the remaining gas to the atmosphere.

The economizer employed is of the counterflow type. The tubes are inclined horizontally, extending transversely to the boiler tubes, a recent development of the Babcock & Wilcox Co. and desirable for its compactness. The gases pass downward over the heating surface, thereby reducing the tendency of dust to settle and lodge on top of the tubes. The water flows upward, thereby avoiding pockets should any steam be formed in the economizer.

These boilers and economizers are provided with a type of soot blower which, if properly operated and properly cared for, will keep the gas passages entirely free from dust lodging, so that it hardly becomes necessary to shut down a boiler for external cleaning.

The fan location is at the floor line and a steel stack is carried on the fan housing. The stack should be of sufficient height to relieve the fan of labor in discharging the gases. It should also be of sufficient height to guard against the gases entering adjoining buildings as they leave the stack.

Some interesting figures are given by the Southwestern Portland Cement Company, in whose plant there are three Babcock & Wilcox units installed. Each unit consists of 7560 sq. ft. of boiler heating surface, 720 sq. ft. of superheating surface, 3750 sq. ft. of economizer surface, and a steel-plate fan capable of handling 120,000 lb. of gas under a pressure of $6^3/_4$ in. water column. These three units are connected to three kilns 150 ft. long by 8 ft. in diameter.

During October and November, 1920, this company generated an average of 1,029,900 kw-hr. per month while burning 52,032 bbl. of clinker. To generate this power they burned an average of 2409 tons of coal under coal-fired boilers, or at the rate of 4.68 lb. per kw-hr. During February and March, 1921, after the waste-heat boilers had been in operation 60 days, they developed an average of 1,200,791 kw-hr. per month while burning 64,109 bbl. of clinker. To generate this 1,200,791 kw-hr. they burned an average of 554 tons of coal under the direct-fired boilers, which was equivalent to 0.95 lb. coal per kw-hr. This shows a saving of 3.73 lb. of coal per kw-hr. or 80 per cent, and a saving of 69.8 lb. of coal, for power purposes, per barrel of clinker burned.

UTILIZATION OF WASTE HEAT IN THE STEEL INDUSTRY

By A. T. LEWIS,[1] BETHLEHEM, PA.

THE steel plant has made wonderful progress in new developments in the last decade, but it is only in recent years that utilization of waste heat has been given much thought.

The prime object in the steel industry has been the development of the material desired without much consideration of how it was to be done. Furthermore the location of the steel industry had been in sections where the raw materials were plentiful, with the result that economy of materials was apparently not very essential. But now, on account of greater competition and the high climbing costs of materials, the steel industry is being forced to give closer attention to economies. This is resulting in the greater utilization of waste heat.

The operations of the steel industry are such that very large quantities of heat are necessary to perform the desired work. Only a small part is being converted into useful work, which leaves a large per cent of energy in the form of waste heat.

Blast Furnaces

Most steel plants are equipped with blast furnaces, open-hearth furnaces, mills, forge and machine shops, power plants and buildings, and they are usually so grouped that the utilization of heat in any branch can be converted into work of benefit to the other departments.

In blast-furnace work the gas was considered a waste product a short time back, and still in many furnaces this valuable fuel is bled to the atmosphere. Even in many modern blast-furnace plants a great improvement can be accomplished in its better utilization. This gas is primarily used for stoves, blowing and power engines, boilers and miscellaneous heating. With properly designed equipment and proper control the maximum economy should be obtained, and the quantities are so large that such economy would spell great savings.

A blast-furnace heat balance shows that approximately 40 per cent of the heat available in the furnace is used in its own operation. This includes preheating of the air and the losses carried away from the furnace and leaves 60 per cent available for other useful work, such as power units, boilers and miscellaneous heating. To realize the importance of the proper utilization of this waste gas an approximate heat balance of a 500-ton blast furnace is given in Table 1.

TABLE 1 APPROXIMATE HEAT BALANCE OF A 500-TON BLAST FURNACE

Total available gas leaving the furnace, cu. ft. per ton iron	128,000
Net heat value of cold gas, B.t.u.	95
Coke rate, lb. per ton	1,917
Air displacement per ton at blowing engines, cu. ft.	116,000
Air heated at stoves per ton (from 160 deg. fahr. to 1115 deg. fahr.) cu. ft.	110,000
Stove efficiency, per cent	60.0
Required by stoves, per cent	32.4
Required by blowing engines, per cent (26 per cent thermal efficiency per air hp.)	8.4
Required by power engines, per cent (23 per cent thermal efficiency per kw.)	21.6
Available for boilers, per cent	37.6
	100.0
Cu. ft. gas per lb. net coke	70
Cu. ft. air to stove per lb. coke	66

Since large quantities of material are dealt with, the steel plants are giving closer attention to the proper use of this gas than they ever did. Beyond the present development of efficient burning of the gases in stoves, boilers and gas engines there is a further development that can be placed to good use, namely, the utilization of the waste heat in gas engines. This will be dwelt on later.

Open-Hearth Furnaces

A steel plant is not complete without a series of open-hearth furnaces. The highest temperature that can be obtained from fuel is desired in the refining of steel. For this process a relatively small percentage of the available heat of the fuel is abstracted, which leaves a very high percentage to pass out from the furnace. A small part of this heat leaving the furnace is recovered in the preheating of the incoming air and gas. In a 70-ton open-hearth furnace from 70,000 to 100,000 lb. of gas normally enters the stack per hour at a temperature of from 1000 to 1200 deg. fahr., and this heat should be utilized. The steel mill usually requires a large generation of steam. The utilization of this heat by means of waste-heat boilers is a means of reducing considerably the total steam-generating costs.

The fuel usually employed is producer gas, unless coke-oven or natural gases—of higher calorific value—are available. In order to develop the necessary temperature and also to effect economy of fuel the air for combustion is preheated before entering the furnace. Where the more sluggish producer gas is used, it is also preheated, which enables it to ignite more readily than when cold. When coke-oven or natural gas are used they are introduced into the furnace without preheating because they are high in hydrocarbons which disintegrate at temperatures above 1000 deg. fahr., thereby causing great fuel loss. In the average open-hearth furnace it will be well to note that of the heat absorbed and the heat that is available for waste heat development—

18 per cent is abstracted for useful work
3 per cent is lost in the sensible heat of the slag
40 per cent is lost in the sensible heat of the stack gases, and
39 per cent represents other losses such as radiation, etc.

The largest item is the heat lost to the stack, and in many furnaces this amounts to more than 50 per cent. To reduce it the

[1] Bethlehem Steel Co.

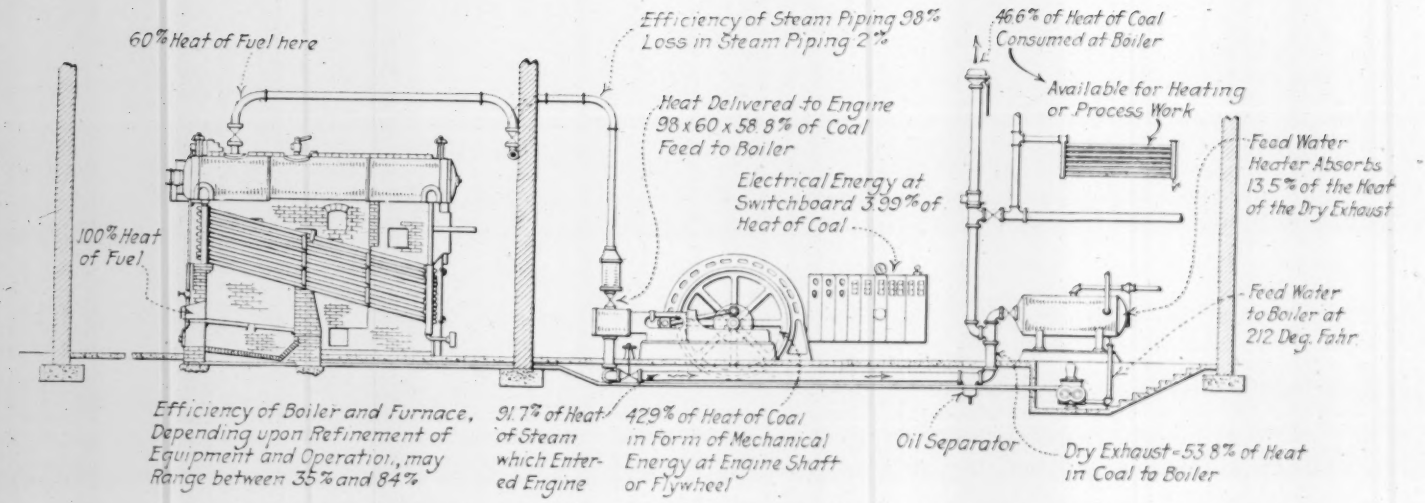

FIG. 1 TYPICAL POWER-PLANT INSTALLATION WITH SIMPLE ENGINE DIRECT-CONNECTED TO GENERATOR

steel plants have resorted to waste-heat boilers by means of which about fifty per cent of the loss can be converted into steam. Furnace gases normally enter the boiler at from 1000 to 1200 deg. fahr. and are reduced to a temperature of from 450 to 550 deg. fahr. before leaving. A well-designed boiler equipment with necessary flues is an asset in the operation of a furnace, since the draft may be regulated by the fan speed at the will of the furnace operator. Furthermore, the value of this abstracted heat is equivalent to 60 boiler hp. per ton of steel. This is equivalent to at least 350 boiler hp. per furnace of about 70 tons capacity and is valued at $3.50 per hour, using anthracite steam coal at $3 per ton as a basis for calculation. It amounts to $2500 a year per furnace and is the best way of recovering heat energy that would otherwise be lost at certain times in metallurgical processes.

Mill heating furnaces have a lower exit temperature than open-hearth furnaces, and if the proper state of combustion is maintained and the furnace is designed correctly a higher thermal efficiency should result. The exit temperatures of mill furnaces vary from 850 to 2000 deg. fahr. and the quantity of heat generated is dependent upon the capacity of the furnace. A waste-heat boiler installation on such furnaces makes an ideal layout and fits in nicely with the steel-mill boiler plant. Table 2 shows a typical heat balance of an open-hearth furnace including waste-heat boiler.

GAS VERSUS STEAM POWER

Modern steel plants that have blast furnaces are usually equipped with gas-engine installations. Gas engines have shown marked improvement in recent years and are employed on account of the low total cost of operation, which is particularly true in the blowing units. This is caused by their relatively high efficiency when compared to steam units.

TABLE 2 TYPICAL HEAT BALANCE OF AN OPEN-HEARTH FURNACE INCLUDING WASTE-HEAT BOILER[1]

	B.t.u. per hour	B.t.u. per ton ingots	Per cent of heat in coal	Per cent of heat in fuel gas	Per cent of heat to furnace
Coal to gas producers	52,500,000	7,000,000	100.0		
Producer loss	8,610,000	1,150,000	16.4		
HEAT DELIVERED TO FURNACE:					
Gas from producers	43,890,000	5,850,000	83.6	100.0	
Combustion of C, Si, and Mn in charge	9,370,000	1,250,000	17.8	21.4	
Sensible heat of hot metal	3,450,000	460,000	6.6	7.9	
Total heat to furnace except regenerated gas and air	56,710,000	7,560,000	108.0	129.3	100.0
DISTRIBUTION OF HEAT:					
Consumed in furnace and losses	31,450,000	4,192,000	59.9	71.8	55.5
Utilized in boiler	15,510,000	2,068,000	29.5	35.3	27.3
Wasted to stack at 500 deg. fahr.	9,750,000	1,300,000	18.6	22.2	17.2
Total	56,710,000	7,560,000	108.0	129.3	100.0

[1] Results based on the following empirical data:

Size of heats, tons	75
Time per heat, hours	10
Hot metal in charge, per cent	64
Ratio of product to charge, per cent	88
Fuel consumption (4875 lb. per hr. or) lb. per ton	650
Heat value of coal, B.t.u. per lb.	10700
Weight waste gases at boiler, lb. per hour	81400
CO_2 in waste gases at boiler, per cent	12
Temperature of waste gases at boiler inlet, deg. fahr.	1200
Temperature of waste gases to stack, deg. fahr.	500
Performance of boiler under above conditions, boiler hp.	460

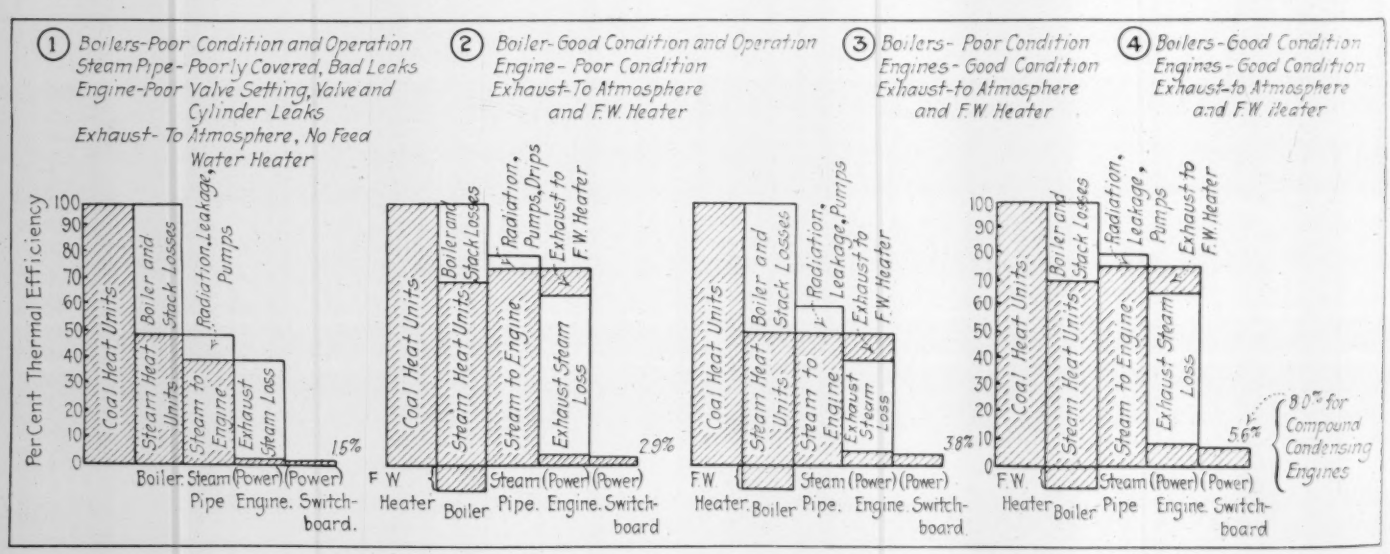

FIG. 2 APPROXIMATE HEAT BALANCE, SIMPLE AND COMPOUND ENGINES

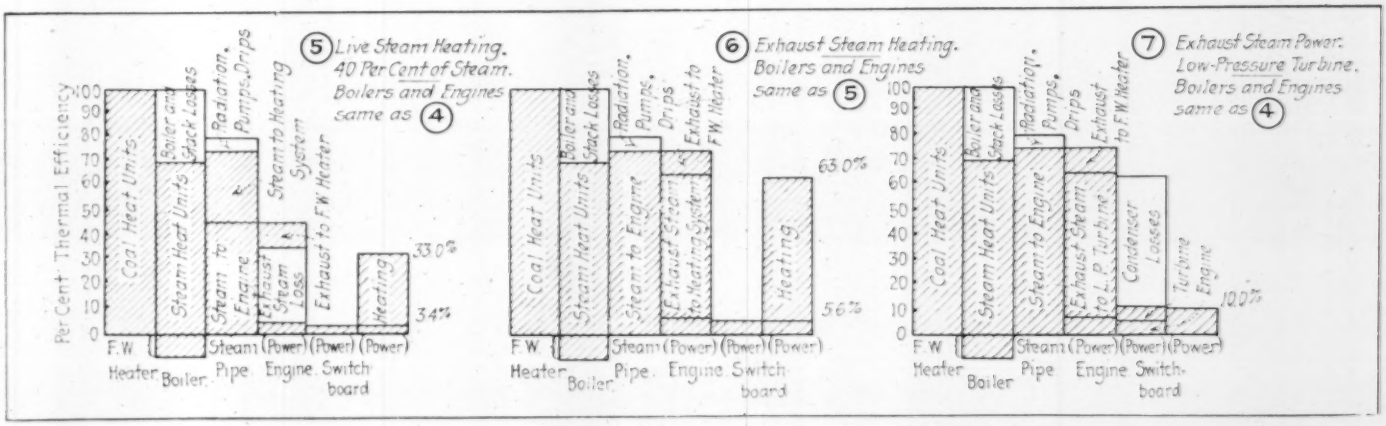

FIG. 3 APPROXIMATE HEAT BALANCE, SIMPLE ENGINES AND TURBINES, EXHAUST STEAM USED FOR HEATING

It will be well to consider the percentage heat balance of a gas engine and compare it to that of a steam engine as follows:

	Gas engine	Steam engine
Effective work	28	11
Friction in engine	5	2
Exhaust gases	36	
Exhaust steam		57
Cooling water and radiation	31	
Boiler loss		30
	100	100

The total gas-engine efficiency can be raised to above 60 per cent, which establishes it as a most economical thermal unit. The development of waste-heat utilization in gas-engine installations should create a greater demand for this type of prime mover in the future, and it will show up to better advantage as the price

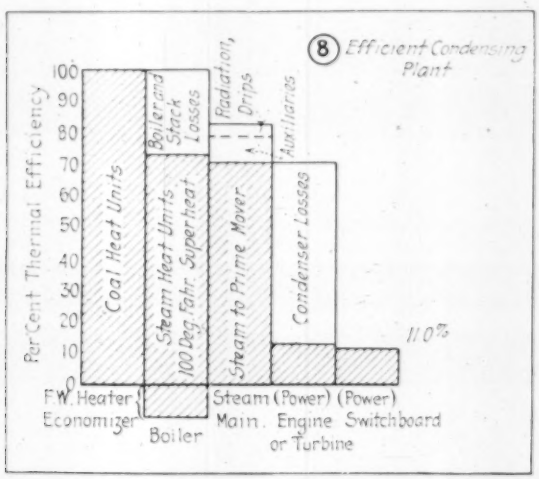

FIG. 4 APPROXIMATE HEAT BALANCE OF LARGE POWER STATION, CONDENSING PLANT

of fuels increase. A very high efficiency is readily obtained by installing waste-heat boilers or economizers in the gas-engine exhaust and utilizing the jacket water either for feedwater, heating buildings, or any other scheme that will fit into plant conditions.

In the steel industry, before the product is finished it goes through many processes where mechanical work has to be performed. This is usually done by steam units such as mill engines, steam hammers, steam pumps, etc. These types of units perform their necessary work very well mechanically, but thermally they are very inefficient. Since they perform their work satisfactorily it is necessary that some means be employed to reduce the cost of operation of such units by converting this very high thermal loss into useful work. To realize the effective work performed by such similar units it is well to examine a few sketches. Fig. 1 shows a diagrammatic heat balance of a typical power-plant installation where the power is derived through a simple engine. This diagram shows the heat extracted from the coal to do its necessary work in the engine and the heat available in the exhaust steam, and indicates the manner in which this exhaust steam can be utilized. Carefully note that in this case 91.7 per cent heat of the steam is available in heat energy after it has done its necessary work in the engine. Further utilization can be effected by the means as shown in the diagram.

Figs. 2, 3 and 4 give approximate heat balances of various steam-consuming units and indicate the available steam beyond the direct consuming unit to be used for other purposes.

It is such units as shown by the heat balances that the steel industry has to contend with. In the warm months of the year exhaust steam is usually not required for heating purposes, but it can be utilized to great advantage if introduced into low-pressure turbines.

UTILIZATION OF WASTE HEAT FROM ROTARY CEMENT KILNS

BY JOSEPH BROBSTON,[1] NAZARETH, PA.

IN America, portland cement is burned exclusively in what is known as a rotary kiln. This is strictly an American development. It has always been known that it was not an economical method of burning, but as coal was cheap and labor high in America, it was universally adopted immediately after its introduction, whereas in Europe where coal was dear and labor cheap, the old style upright kiln similar to a lime kiln held its own up to within a few years.

While the largest loss of heat in the rotary kiln was in the excessive temperatures of the flue gases, there were two other important heat losses which were at that time attracting attention, one being the heat carried off by the material or resulting clinker, when it was discharged from the kiln; the other being the loss by radiation through the kiln shell.

There was one notably successful attempt made to utilize a part of the heat of the flue gases. In the dry process of cement manufacture it is necessary to dry the raw material before it can be pulverized. Charles Matcham put his stone dryers immediately back of his kilns, and passed a portion of his kiln gases through them. This did not affect the operation of his kilns, dried the stone more effectively, saved about three to four pounds of coal per barrel of cement made and materially reduced the labor charge in connection with the drying. Only a small percentage of the total stack gases were required for this, however, and there were not many of the installations made.

The sporadic efforts made to use the waste heat of rotary kilns prior to the sudden and material increase in the price of coal caused by the war, did not amount to more because of the very low price that the industry as a whole paid for its kiln coal. The coal generally used is the slack or screenings from $^3/_4$ gas coal. This was formerly considered a waste product by the coal mines and had to be moved when the $^3/_4$ coal was shipped, which resulted in a price to the cement industry ranging from 20 to 75 cents a ton at the mines. The cost per barrel for burning cement was therefore comparatively low and the efforts of the

[1] Vice-President, Dexter Portland Cement Co. Mem. Am.Soc.M.E.

manufacturers were mainly directed to installing labor-saving machinery and reducing the cost of pulverizing the raw material and clinker.

When the price of coal jumped to $5 per ton at the mines, however, conditions were entirely different, and in 1915 the first modern waste-heat boiler plant in the cement industry was installed at the Catskill plant of the Alpha Portland Cement Company. This installation was a success from the start. The plant operates five kilns, three being 9 ft. in diameter by 120 ft. long and the other two 7½ ft. 6 in. in diameter and 120 ft. in length, resulting in an output of about 3000 bbl. of cement per day. The gases from these kilns are drawn into a main or equalizing flue directly in the rear of the kiln housing or dust chamber, dampers being installed to by-pass gases into the kiln stacks, if necessary. Connections leading from the back of this flue conduct the gases to two 750-hp. Edge Moor boilers, of the four-pass type. Two Green fuel economizers, horizontal type, are installed after the boilers. The forced draft is provided by a fan located directly back of the economizers, driven by a Terry turbine. A steam pressure of 175 to 180 lb. is maintained, and sufficient power is generated to operate the entire plant. The finely pulverized stone carried over from the kiln by the hot gases is blown from the boiler tubes three to four times in each 24 hours, a hand lance using 140 lb. of air being employed for this purpose. The economizer tubes are blown off through plugged openings in the top of the casing several times each week. The clean-out doors at the bottom of each pass are opened once a week and the dust removed. Clean-out doors are also provided in the flues. In this way, if the draft at the stack chamber is not allowed to drop below 0.25 in. (water pressure), no real difficulty is experienced in keeping the installation free from dust. The temperature of the gases is reduced from approximately 1400 deg. fahr. at the mouth of the kiln to about 450 deg. when they leave the economizer. The Cochran feedwater heater is heated by the exhaust steam from the pumps and fan turbine. The operation of the boilers has not increased the amount of coal used per barrel in the kilns. It is about 95 lb. per bbl. It requires not less than 40 lb. of coal per bbl. to generate the power required to operate a cement mill. Deducting this from the 95 lb. being used in the kiln we find that today this company is burning their cement with 55 lb. of coal, which is much closer to the theoretical amount required, that is, 30 lb., than the cement manufacturers had ever hoped to come, and means that a rotary kiln with a waste-heat boiler attached is as economical in its coal consumption as the old-style upright kiln. Plants almost exactly duplicating the one described were promptly installed at another plant of the Alpha Portland Cement Company and at the Dexter Portland Cement Company, and plants using B. & W. boilers were installed by the Universal and Louisville cement plants.

By this time all the manufacturers of portland cement were aware of the importance of this development, and the Conservation Committee of the Portland Cement Association, started an extensive investigation of the entire question. The first report presented in December, 1918, showed eight plants in operation. Today there are 24 plants in operation generating with their flue gases from 51 to 140 per cent of the power they require. There are about 120 operating portland-cement plants in the United States, so that 20 per cent of the plants are now making use of their stack gases, saving on the average 40 lb. of coal for every barrel made. This means that these companies are actually using about 400,000 tons of coal less per year than they did formerly.

It may be noted that in some cases more steam than is required to operate the entire cement plant is generated by the waste-heat installation. In other cases only a little over one-half of the amount required is secured.

While this is to a certain extent a question of the efficiency of the boiler installation, it may be due to other causes. The plant that is burning cement with 80 lb. of coal to the barrel will not have the volume of stack gases or temperature that will be found at the plant using over 100 lb. to the barrel, so that naturally not as much steam can be generated. The total amount of coal used per barrel, however, may be lower at the plant using the 80 lb., as it may be possible to generate the additional power required in auxiliary boilers with less than the extra 25 or 30 lb. of coal consumed in the kiln.

But even when two waste-heat plants generate the same amount of steam, there may be a great difference in the percentage of the machinery that can be run with it. Where the amount of steam secured is just sufficient to operate a mill in which the prime movers are well-designed modern turbines, it would probably be only 75 per cent of the steam required to operate another plant which is still being run with old-style inefficient reciprocating engines.

Power Required to Grind a Barrel of Cement

Where the prime movers are identical, there might still be a wide difference in the percentage shown. Recent investigations made by the Conservation Committee of the Portland Cement Association show that the power required to produce a barrel of cement at plants using different types of grinding machinery varies from about 13 kw-hr. per bbl. to about 19 kw-hr.

Some progress has also been made in the last three or four years in solving two other problems. The loss through radiation is being materially reduced by putting between the shell and the firebrick lining in the upper part of the kiln, a brick cut from diatomaceous earth. While it has not been possible to determine the exact amount saved in this way, it has been shown conclusively that where waste-heat boilers are being used this insulation raises the temperature of the flue gases 150 deg., and where boilers are not installed the insulated kilns require from 5 to 10 lb. per bbl. less coal to burn clinker than those not insulated.

This problem is not as yet fully solved, however, as it has been found impossible to use the insulating brick in the hottest section of the kiln, known as the burning zone. Here the fluxing action of the clinker at the high temperature necessarily maintained was such that the firebrick were practically destroyed in from 16 hr. to four days. The hot zone can undoubtedly be insulated by using carborundum, but at the present time the cost of doing this would be prohibitive.

The Technical Problems and Conservation Committees of the Portland Cement Association are working on this problem with the firebrick manufacturers and it is hoped that a suitable block that will stand up and which can be made at a reasonable price, will be developed.

Possibility of Reclaiming Heat Carried off by Clinker

As to the possibility of reclaiming the heat carried off by the clinker, the development of the rotary pressure cooler in the last few years has demonstrated that where the cooler is of sufficient size and proper design to handle the kiln output it is possible to heat the air entering the kiln to a temperature of 800 to 900 deg. fahr. and to have enough heat left over to dry the coal used for kiln operation. How much this saves is problematical. So far the power required to operate the system has been found to be so great that there appears to be very little actual saving.

In the ideal cement plant of the future there should be no wasted heat. Where the engine room is equipped with the modern economical type of prime mover, and the mill has been designed and equipped with grinding machinery that requires the minimum amount of power, the stack gases will generate not only sufficient steam to run the plant and heat the buildings, but there will be enough left over to dry the stone. All the heat will be drawn from the clinker and it will be sufficient to raise the temperature of the air required to support combustion in the kilns to a point that will materially reduce the amount of coal needed for burning, and there will be enough left over to dry the coal before it is pulverized.

With the preheating of the air and the insulating of the balance of the kiln, the amount of coal required to burn should certainly not be over 75 lb. to the barrel. Deducting from this the 40 lb. required for power, the 3 lb. required for drying the stone and 1 lb. each for drying the coal and heating the buildings, the theoretical figure of coal required to burn a barrel of cement is reached, namely, 30 lb. per bbl.

While this ideal may never actually be attained, the work on all three problems has progressed far enough to show that within the next five years through the insulation of kilns, the preheating of the air going to the kilns, and the use of stack gases, there will be saved in producing 100,000,000 bbl. of portland cement, besides the 400,000 tons already mentioned, about 1,600,000 tons, or a total of 2,000,000 tons due to the utilization of waste heat.

Paint Protection for Wood

By CORNELIUS T. MYERS,[1] RAHWAY, N. J.

ABOUT two years ago the writer, in carrying on some research work on wood wheels had occasion to make inquiry among paint manufacturers as to the value of various kinds of paints and primers for the protection of wood against moisture. This inquiry brought out so many differences and variations in opinion as to paint materials and mixture proportions that a more extensive inquiry among paint men was started. This inquiry revealed that:

(1) There was comparatively little technical information to be gained from the paint industry on the relative protective values of different coatings for wood

(2) The paint industry did not generally recognize the moisture-proofing of wood as a problem, but was concentrating so far as the more reputable manufacturers were concerned on producing paints that would last as long as possible on the surface to which they were applied. In other words, such improvements as have been made have contributed to the life of the coating rather than the life and usefulness of the article which received the coat.

As the demand upon our forests depends to a very considerable extent upon the life of forest products, and as the life of these products in many cases depends to a very considerable extent upon the protection against moisture they receive, the intimate knowledge of protective coatings is a factor of great importance in our lumber conservation program; to say nothing of the possible saving in our $300,000,000 annual paint bill. Wood in its natural green condition has a very limited use as a structural material. Its tiny fibres are cellular in form and contain a large amount of moisture, commonly known as sap, the sap being water containing very small percentages of tannins, sugars, gums and coloring matters. To give wood the physical qualities which make it fit for use in buildings, furniture, truck bodies, wheels, etc., it is necessary to remove most of the moisture.

Moisture in Wood

Wood is said to be oven-dry when continued oven drying causes no further loss of weight. In their green state the woods used structurally have a moisture content of 60 to 120 per cent of their oven-dry weight, and weigh roughly from 60 to 120 per cent more than when they are in an oven-dry state. In other words, 35 to 55 per cent of the weight of a green log is water. In the green log this water exists in two conditions:

(1) Minute particles of water in each tiny wood cell cavity, known as "free water"

(2) The moisture absorbed by the fibrous material which forms the walls of the cells, known as "hygroscopic moisture."

Felled wood exposed to average atmospheric conditions gradually dries, the air taking up its moisture. First the cell cavities slowly give up their moisture. This evaporation goes on until the cell cavities are emptied of the minute particles of "free water" they contain. All that remains is the moisture actually absorbed by the fibres of the cell walls, which are still saturated with the "hygroscopic moisture." Wood in this state is said to be at its "fibre-saturation point." Up to this time the wood does not appreciably change in size or in physical characteristics except as to weight, which of course decreases considerably as it will now contain but 25 to 30 per cent of moisture instead of 60 to 120 per cent.

Further drying of the wood is necessary in order to increase its strength and hardness, increase its durability, enable it to take and hold paint, and in general to improve its condition for the purpose intended. As this drying progresses beyond the fibre-saturation point, the cell walls give up the moisture they have absorbed, and in so doing they shrink and harden. Under natural conditions this drying process will continue until the amount of moisture in the wood bears a quite definite relation to the average humidity condition in the particular locality. (See Fig. 1.) In the eastern and north central states, for instance, the moisture content of wood will become stabilized somewhere in the neighborhood of 14 per cent for what is known as thoroughly air-dried stock. In the arid, southwestern states it will contain a still lower percentage, while in the former war zone of France the wood will normally contain considerably more than 14 per cent of moisture. Of course unpainted wood that is exposed to rain and snow will absorb considerably more than 14 per cent, depending upon the dimensions of the piece and the extent of the exposure.

Data secured from the Forest Products Laboratory of the United States Department of Agriculture show that

(1) Many woods should be dried to about 8 per cent moisture content to give the best results as to strength, durability, hardness and finish (See Table I)

(2) It is also true that if after being dried, and shrinking in the process, wood reabsorbs moisture, it will swell again according to the amount absorbed

(3) The shrinking and swelling along the grain, perpendicular to the grain and tangential to the grain all differ, and very materially, for a given change in moisture content. (See Table 2.)

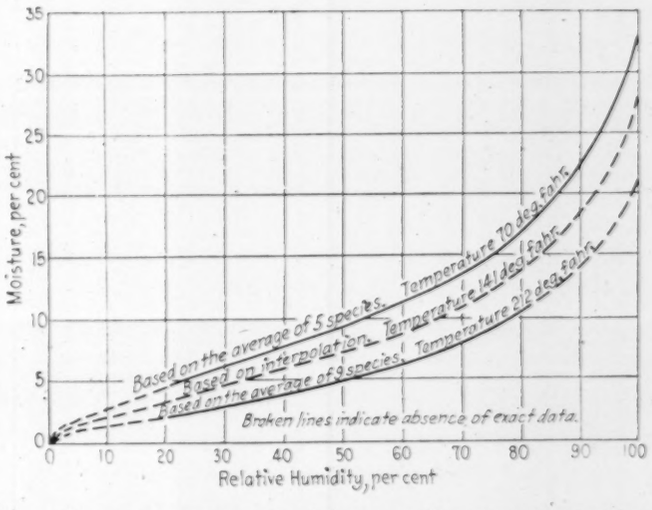

FIG. 1 RELATION BETWEEN THE AMOUNT OF MOISTURE ABSORBED BY WOOD AND THE AVERAGE RELATIVE HUMIDITY

From the two following tables it will be seen that it is quite

TABLE 1 APPROXIMATE PERCENTAGE OF INCREASE IN STRENGTH OVER GREEN[1]

	Dried to 14 Per Cent Moisture	Dried to 8 Per Cent Moisture
Bending strength, modulus of rupture	40 to 60	80 to 160
Compression parellel to grain	80 to 90	100 to 150
Compression perpendicular to grain	65 to 75	
Stiffness, modulus of elasticity	20 to 30	25 to 35[2]
Hardness	30 to 35	40 to 50[2]
Shearing strength, parallel to grain	40 to 50	60 to 70[2]

[1] Compiled from Data given in Timber, Its Strength, Seasoning and Grading by H. S. Betts.
[2] Estimated.

TABLE 2 SHRINKAGE AND MOISTURE CONTENT OF HARDWOOD[1]

	Specific Gravity of Dry Wood	Shrinkage[2] in Per Cent of Green to Oven-Dry Radial	Shrinkage[2] in Per Cent of Green from Green to Oven-Dry Tangential	Green Moist in Per Cent of Dry Wood Wt.
Ash, white[3]	0.57	4.8	7.0	39
Birch, yellow[3]	0.55	7.4	8.9	68
Elm, cork	0.57	4.8	8.1	53
Hickory[4]	0.64	7.2	10.9	60
Maple[5]	0.51	4.2	8.5	63
Oak, red[3]	0.56	3.9	8.3	83
Oak, white[5]	0.60	5.3	8.8	66
Average	0.57	5.4	8.6	62

[1] Compiled from data given in Kiln Drying of Lumber by H. D. Tiemann
[2] Average shrinkage along the grain, up and down as the tree grows, is only about ½ per cent.
[3] Average of 2 species
[4] Average of 9 species
[5] Average of 3 species

[1] Consulting Engineer. Mem. Am.Soc.M.E.

desirable to have wood thoroughly dried, and that steps should be taken to keep it so. But although it is easy to reduce the moisture to 8 per cent in dry kilns, it is difficult to maintain the wood at this point; because of unsuitable protective coatings, or processes, and because of the lack of knowledge as to relative ability of various coatings for really stabilizing the moisture content within a small range.

Protectiveness of Paint

While we know that several coats of good paint may give adequate protection for floors, truck bodies, furniture, wheels or other wooden articles, we by no means know what paints give the best protection or what paints will give fairly satisfactory protection for the least

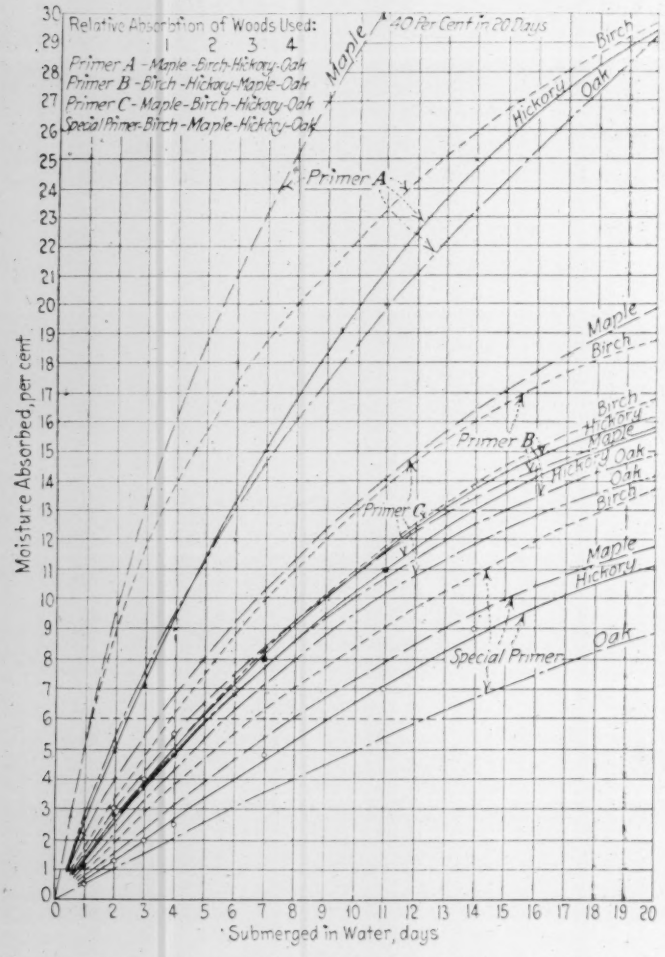

Fig. 2 Curves Showing How the Effectiveness of Different Primers as Moisture-Proofing Agents Varied for Different Woods

money. The test fences, where many different paints were exposed to the same atmospheric conditions, have given some data on the durability of paints, but very little data on the durability of the painted article or its dimensional stability. *In durability and dimensional stabilization we are greatly interested;* in the first for very obvious reasons, in the second because wooden structures, furniture, etc., are more durable, serviceable, and can be made more simply if their various component parts do not expand and contract with changing wheather conditions. The cost of drying could be reduced in many cases, if when dried to a certain point the moisture content could be stabilized. Wood, on account of its very valuable characteristics, could be used in places where metal now seems necessary. A dozen or more prominent concerns in the paint industry have been coöperating very commendably in this research work, realizing that the dimensional stabilization of wood by moisture-proofing was a proper function of paint and of world wide importance. There is, however, quite a difference of opinion among these manufacturers as to what materials should be used, and how they should be mixed and applied. During the war the Forest Products Laboratory investigated the moisture-proofing effects of linseed oil and various paints, varnishes and leaf-metal coatings as applied to airplane-propellers and other airplane parts made of wood, but this work has not been broadened because of lack of funds.

In order to get some comparative data on the paints and primers now on the market, the following schedule was drawn up by the writer, and tests were made on small pieces, measuring 1 × 1 × 1 in., of hickory, oak, birch and maple by several well known paint concerns:

(1) Dry slowly and completely until pieces cease to lose weight
(2) Determine "oven dry" weight
(3) Allow reabsorption to 8 per cent
(4) First coating to be applied at 8 per cent moisture content
(5) Second coating to be applied at 8 per cent moisture content
(6) Third coating to be applied at 8 per cent moisture content
Note: 24 hrs. to elapse between 4 and 5, and 5 and 6.
(7) Allow the three coatings to dry for a week under conditions of 70 to 80 deg. fahr. temperature, 40 per cent relative humidity, under which condition the moisture content of the wood should remain at 8 per cent even if the wood had no protective coating
(8) Label and weigh for base weight at 8 per cent moisture content with protective coating
(9) Submerge in water at 70 deg. fahr.
(10) Weigh every 24 hr. for first week, every 48 hr. thereafter and determine percentage of increase in moisture
Note: *Please bear in mind, of course,* that whatever is used in the way of coatings, it must serve as a suitable foundation for subsequent coats of paint and varnish.

In general, the results of the tests showed that paints of the ordinary brands and formulas were not very effective as moisture-proofing agents, even when three coats were applied. One paint concern after testing its standard brands, did a little experimenting, and without much difficulty was able to produce a special primer that was several times as effective. The curves in Fig. 2 show quite emphatically the variation in effectiveness of the paints used. Averaging the results for hickory, oak, maple and birch, it took about six times as long for these test pieces to absorb an extra 6 per cent of moisture when coated with the "special" as when coated with the standard "A." There is every reason to believe that much better results can be secured and with less than three coats. Preliminary tests with a casein solution indicate that it has waterproofing qualities, which, for some classes of protection, may be very valuable. The same is true of some of the pyroxalin compounds. Varnishes are in general more effective than paints, but in the protection of wheels its application was not suitable for primary coats.

Need for Research

What has been said so far shows the need for research work on this subject. Cabinet and furniture makers are vitally interested in a coating which will prevent wood from "working," shrinking and swelling, due to atmospheric changes in winter and summer. Interior woodwork could be greatly simplified if the dimensions of each particular piece of wood remained the same or varied but a very small amount. Flooring, decking, paneling, etc., would be greatly benefited if it did not "work." Many wooden structures would be simpler and more permanent if so protected, and with thoroughly dried timber they would either have a greater factor of safety or could be built with less lumber. Many other advantages will develop as thought is given to this subject—*The Dimensional Stabilization of Wood by Rendering it Moisture-Proof to Some Substantial degree.*

It is well known that shingles and weather boards fastened with old fashioned wrought-iron nails stay tight much longer than those in which the modern steel nail is used. The reason for this is that the steel nail rusts and is flaked off by the movement, or "working," of the piece through which it is driven. A nail tightly driven is practically sealed against external moisture by its head and the paint around it; but if moisture reaches the nail by the capillary action of the wood fibers, it will rust in spite of end sealing. Then too the moisture and capillarity of the wood cause the "working"

Continued on page 545

Welding Session Develops Salient Facts

Gathering Under Auspices of American Welding Society and A.S.M.E. Boiler Code Committee at Atlanta Meeting Emphasized Problems to be Met in Advancing Art of Welding

THE search for dependable information about the strength of welded pressure vessels which the A.S.M.E. Boiler Code Committee has been conducting for the past few years resulted in an exceedingly interesting session at the Atlanta Spring Meeting of The American Society of Mechanical Engineers on May 11, 1922. The session was arranged jointly by the American Welding Society and the A.S.M.E. Boiler Code Committee and was presided over by E. R. Fish, Chairman of the A.S.M.E. Boiler Code Sub-Committee on Air Tanks and Pressure Vessels.

Four papers were presented at the session, namely: Strength of Electrically Welded Pressure Containers, by R. J. Roark, Madison, Wis., assistant professor of mechanics, University of Wisconsin; Some Principles of the Construction of Unfired Pressure Vessels, by S. W. Miller, proprietor of the Rochester Welding Works, Rochester, N. Y.; Steel for Forge Welding, by Frank N. Speller, metallurgical engineer, National Tube Co., Pittsburgh, Pa.; and Tests on Welded Cylinders, by E. A. Fessenden, professor of mechanical engineering, Rensselaer Polytechnic Institute and L. J. Bradford, assistant professor machine design, Pennsylvania State College. Professor Roark's paper, slightly abridged, appeared in the April issue of MECHANICAL ENGINEERING, Mr. Miller's in the June issue, and Mr. Speller's in the July issue. The paper by Professors Fessenden and Bradford will be published in an early issue. These papers brought out a large amount of valuable discussion, both written and oral, liberal extracts from which immediately follow.

DISCUSSION OF PROFESSOR ROARK'S PAPER ON THE STRENGTH OF ELECTRICALLY WELDED PRESSURE CONTAINERS

S. W. Miller[1] wrote that the paper was very instructive in that it showed the inherent weakness of heads convex to the pressure. It should be noted that the nipple in specimen No. 1 was a source of weakness and that great care must be taken in designing pressure vessels to avoid such weakness.

In the case of the longitudinal seams failure occurred in all cases by breaking through the weld. Little was said about the kind of welding wire used, but the chemical analysis showed it to be low in carbon and manganese, and evidently it was much weaker in the weld than the plate, which was of high tensile strength, 64,000 lb. The carbon in the plate was given as 0.12 per cent, but it would hardly seem correct that a tensile strength of 64,000 lb. could be obtained with so low a carbon content. Also the carbon in the weld metal was given as 0.18 per cent, which was not possible with welding wire containing only 0.07 per cent carbon. Electric welds made with such wire contained 0.03 to 0.04 per cent carbon. This pointed to the necessity of careful sampling of weld metal. There was quite an interchange of carbon between the plate and the weld metal and no samples should be taken closer than $^1/_{16}$ in. to the original line of the V.

With regard to the microphotographs shown, the magnification was not given but it was probably not over 100 ×, which was not sufficient to determine the structure of welds except in a general way. Electric welds made with bare wire were noticeably full of particles of ferrous oxide which required about 400× for their resolution.

The question of tests for welded containers was a very important one, and some means must be devised for so testing welded pressure vessels that such imperfect welds as had been described could not get into service. The danger did not arise from a steady pressure, but from alternating stresses or shocks which were liable to occur in any pressure vessel. Also temperature differences at times introduced unknown and unknowable stresses.

A large number of tests led him to believe that the tensile strength of thin films of such foreign matter as oxide in welds was of the order of 40,000 lb. per sq. in., but under shock combined with tensile stress rupture would occur at a much lower figure.

[1] Proprietor Rochester Welding Works. Mem. Am.Soc.M.E.

C. L. Jones[2] submitted a written discussion in which he said he was surprised to note that the low average tensile strength of electrically welded joints was given at 28,500 lb. per sq. in. and the shearing strength at 25,500 lb. per sq. in.

To show that the values were low Mr. Jones cited a number of similar tests, conducted along the same lines as shown by the author. One in particular was conducted on four arc-welded ammonia receivers 16-in. diameter, $^1/_4$-in. plate material, by the York Manufacturing Company about two years ago, and reported in the 1921–1922 Proceedings of the American Welding Society by A. M. Candy. The welded joints were tested for brittleness by dropping a 10-lb. weight on them from a height of 10 ft. These blows, however, produced no visible effects on any of the joints. Following this the containers were tested to destruction.

Upon inspection it was observed that three of the tanks had been welded along the longitudinal seam while the seam rested in contact with a heavy backing strip of metal, possibly spaced $^1/_{16}$ in. away from the actual joint. Furthermore, judging from the ruptured joints in the fourth tank the weld was made in at least three layers, which enabled the operator to obtain better fusion at the bottom of the joint with the first layer, and the latter layer improved the grain of the weld. These features readily explain the superiority of the fourth tank (70,400 lb. net) over the others (43,000–48,000 lb.) and illustrated the importance of proper welding procedure.

Numerous tests on pure arc-deposited metal cut entirely away from the plate steel upon which it was deposited have shown an ultimate tensile strength of 50,000 to 58,000 lb. per sq. in., and a shearing strength of from 38,000 to 42,000 lb. per sq. in. Further, the Wirt-Jones test of the Emergency Fleet Corporation reported arc welds of 36,300 to 66,480 lb. U. T. S. per square inch, made by a large number of different operators all over the United States.

He had personally witnessed many tests similar to one in discussion, and had never known of an average running lower than 30,000 lb. per sq. in., and did not recall any running lower than 35,000 lb. He believed that Mr. Miller's reports would show the lowest tensile strength of six specimens to be 39,330 lb. per sq. in., and the highest 45,600 lb.

As further assurance of his claims for higher average tensile strength of electric-arc welds he gave tables of tests, conducted by one of the largest railroads in the South, and one of the largest companies in the country manufacturing railroad and mine equipment. These welds were made under his own personal supervision, and the reports were obtained direct from officials of the companies mentioned. In neither of these tests did the ultimate tensile strength go lower than 35,230 lb. per sq. in., and in some of them it went as high as 76,000 lb. and did not break in the weld.

A. S. Kinsey,[3] discussing the low strength values given for the electric welds, said that they were obtained on single V welds on thin bars, and he believed that they were due in considerable degree to the eccentricity resulting from the large excess of thickness of the weld. If allowance was made for that in computing, the maximum stress would be seen to be about 42,000 lb. per sq. in. In any event the actual strength would be greater than this value, which was really not the strength of the material, but the strength of the wires. Strength, however, was not of so much significance as uniformity. The value of the nickel-steel welding rod was generally acknowledged and it was important that something should be done to standardize its nickel content, which should range from 3 to $3^1/_4$ per cent.

F. N. Speller[4] said that, taking the pressures at which the forge-welded and acetylene-welded cylinders failed and assuming the

[2] Westinghouse Elec. & Mfg. Co., Atlanta, Ga.

[3] Supervising Instructor Shop Practice, Stevens Institute of Technology. Mem. Am.Soc.M.E.

[4] Metallurgical Engineer, National Tube Co., Pittsburgh, Pa. Mem. Am.Soc.M.E.

fiber stress to be 50,000 lb., that being the fiber stress in the weld, the efficiency of the forge weld worked out at 80 per cent and that of the acetylene weld at 48 per cent. It therefore seemed to him that the proper place for acetylene welding on an important cylinder was on the girth seams, and that the longitudinal seams should be forge-welded.

DISCUSSION OF MR. MILLER'S PAPER ON THE CONSTRUCTION OF UNFIRED PRESSURE VESSELS

After presenting his paper Mr. Miller said that since writing it he had discovered a number of things which were of particular interest with reference to the quality of steel for welding.

In making tests on high-strength wires it was of course necessary to have high-strength plate, and ship plate had the highest tensile strength of any of the commercial plates, the upper specification limit being 68,000 lb. Its carbon content was usually about 0.25 per cent when $\frac{1}{2}$ in. thick. Some erratic results had led to a careful examination of some of the plate and of the welds made in it. The results of certain tensile-strength tests had shown a low value and rupture had taken place apparently along the line of the V. A careful microscopic examination showed that in some cases the rupture was parallel with the V at the defects in the base metal. In other cases a large amount of dirt had accumulated at or near the junction of the weld and base metal. These defects were both associated with non-metallic impurities in the plate, the latter being quite clearly so, and the former evidently so, though the connection was not so clear. In the former it seemed clear that at least some of the non-metallic impurities had been absorbed by the austenite when it had reached a temperature somewhat below that of melting. During the cooling and recrystallization these dissolved impurities were rejected to the γ-grain boundaries and became visible there as more or less continuous dark lines, or as spots of grayish matter having the appearance of ferrous oxide. When such a piece was bent and examined under the microscope, the rupture was found to occur at these visible defects.

Another defect which seemed to be of rather frequent occurrence is the accumulation at the bottom of the V of a large amount of ferrous oxide in the shape of minute gray dots and larger particles in size that range from 0.0005 to 0.015 in. in diameter, and sometimes larger. It was quite evident that these impurities were not in the wire as shown by a careful examination of it. Also they seldom appeared except at the bottom of the V.

When using wire that sparked freely, even with a neutral flame, it would be noticed that there were deposited on or near the work large quantities of small spherical particles which were mostly composed of magnetic iron oxide (Fe_3O_4), and which were frequently hollow, although occasionally in the larger ones their centers were filled with iron which had not had time to completely oxidize. These particles were of all sizes from the finest dust to several hundredths of an inch in diameter. They would easily stick to a surface that has been heated, and they actually did this, so that the V near where the torch was working was covered with them. They must be disposed of in some way during the welding, and it appeared quite clear that they might be dissolved in the melted metal, or washed down without having had time to dissolve and settle in the bottom of the V or close to the sides of the V. As most of these particles were very small, they usually escaped observation, and as in some cases they were very numerous, it was very probable that the welder was deceived by this coating melting instead of the metal itself, with the result of an imperfect weld. It seemed quite clear, therefore, that the quality of the base metal must be good if good results were expected, and that welding wire which sparked freely should be watched very carefully during welding. Also the size of wire and size of tip should be so related as to prevent sparking as much as possible.

In any plate impurities were usually found toward the center, which was natural as they occupied a similar position in the ingot. With a single V weld the washing of the melting welded rod naturally carried any impurities down with it toward the bottom of the V so that the weld, if imperfect, would be so toward the bottom of the V. This was almost invariably the case. It was equally true in a double V weld, but this had two advantages. First, the impurities had less surface to scatter over, and second, they were confined to the center of the plate, so that the weld, which was reinforced on both sides, tended to be equally as strong as the plate on account of the weld and plate sections being symmetrical.

J. H. Nead[5] wrote that the author had brought out in his paper the advantages of having the weld stronger than the plate and had stated that this could in general be accomplished in two ways: (1) By using ordinary plate and nickel-steel welding wire; (2) By using Armco ingot-iron plate and Armco ingot-iron welding wire. He believed, however, that all the inherent advantages of the latter method had not been brought out. In designing any structure which was subject to live loads, as most pressure vessels are, it was well to use a material which had a high resistance to fatigue. There had recently been published the report of an investigation on the fatigue of metals carried out by Prof. H. F. Moore of the University of Illinois, under the auspices of the National Research Council. (Bulletin No. 124 of the Engineering Experiment Station of the University of Illinois.) Professor Moore investigated many materials among which was Armco ingot iron and which he designated as 0.02 carbon steel. He found that this 0.02 carbon steel had a higher ratio of endurance limit to proportional limit than any other material. The endurance limit as he defined it was the maximum stress at which the material would withstand 100,000,000 reversals of stress without failure. In other words, that Armco ingot iron was an excellent material to resist fatigue. In the light of this information Mr. Nead believed that a safer pressure vessel could be constructed by the latter of the two above-mentioned methods than by the former.

In the Appendix B of Mr. Miller's paper was reported the performance of several welded pressure vessels under pressure test. The No. 5 tank shown on page 52 of the paper was returned to the American Rolling Mill Company by Mr. Miller after testing and two pieces, size 12 in. by 20 in. were cut out from the side of the tank, one from near each end. These were flattened out and four tensile test pieces cut from each. Two test pieces from each were tested without milling the welds off flush with the plate and two each were milled flush.

Three of the four unmilled specimens showed an average tensile strength of 51,100 lb. per sq. in. and broke in the plate rather than the weld. The fourth specimen broke in the weld (at 45,150 lb.), the fracture starting from a slight defect. In the case of the milled specimens the fracture occurred at the weld, as would be expected, but considerable ductility as indicated by the reduction of area was evident. The breaking load was approximately 48,000 lb. for three of the specimens, and 55,000 for the fourth.

The carbon content of the weld metal from nickel-steel electrodes was given as 0.14 per cent on page 29 of the paper. The figure was taken from the American Rolling Mill Co.'s report and should read 0.04 C. instead of 0.14 C.

S. G. Child[6] in a written discussion called attention to the author's statement that "the base metal most successful for autogenous welding is a low tensile steel of 0.15 per cent maximum carbon content," the objection to a higher carbon content being the danger of burning the steel in the operation of welding.

It was desirable before legislating on the permissible materials for welding to investigate the present commercial practice in the manufacture of welded pressure vessels. He was identified with a manufacturing plant which had for many years successfully welded pressure vessels made from the standard grade of boiler steel, of the grade specified in almost identical form in the A.S.M.E. Boiler Code, in the A.S.T.M. specification A–30, in the American Railway Association specifications and the standard specifications of the Association of American Steel Manufacturers. The tensile strength of this grade was 55,000 to 65,000 lb. per sq. in. and the carbon content usually from 0.15 to 0.25 per cent.

All locomotive boilers were built of this grade of material and were satisfactorily welded both during construction and when undergoing repairs in the railroad shops. No trouble from burning the material was experienced. If a poor weld was made by an inexperienced operator it was usually detected by a visual inspection and the part chipped out and rewelded. If the inspector failed to detect a poor weld on surface inspection it was invariably detected

[5] Metallurgist, Research Dept., American Rolling Mill Co., Middletown, Ohio. Mem. Am.Soc.M.E.

[6] Asst. Supt., Baldwin Locomotive Works, Philadelphia, Pa. Mem. Am. Soc.M.E.

and corrected when a test pressure greatly in excess of the working pressure was applied to the vessel.

He had made a careful investigation of the manufacture of welded unfired pressure vessels and found substantially the same result, namely, that the standard grade of tank or boiler steel having tensile limits of 55,000 to 65,000 lb. per sq. in. and usual carbon limits of 0.15 to 0.25 per cent ordered to the requirements of the specification of one of the above-mentioned organizations, was almost universally used.

F. N. Speller[6] asked the author whether he took into account the weakness of the metal near the weld incident to the heating of the plate. This was something that should be considered in discussing the strength and efficiency of a weld. The quality best suited for forge welding was not necessarily the best for acetylene or electric welding.

Stafford Montgomery[7] said that he gathered from the papers that there was a tendency in plain welding for foreign particles included in the base metal to migrate to the region of the weld, there forming a belt of weakness; and asked whether the author had observed in the case of resistance welding or welding under pressure, that the method tended to force out in the form of a slag such foreign particles as were usually found in that class of weld.

In his closure Mr. Miller said that as regarded efficiency of the weld he referred to cases where it was less than 100 per cent, which was always the case where the welding wire was of low-carbon steel—of low tensile strength and the plate of high tensile strength. In the tanks referred to in the paper the tensile strength of the weld was higher than the tensile strength of the plate, and purposely made so.

In order to ascertain what the conditions were, after the tank tests he had cut out a piece about 18 in. square from across the weld and then cut two different pieces from it, straightened them cold on an anvil and tested them. The plate had a tensile strength of 50,000 lb. originally and the tests were made after the tank had been stretched 7 in. It was possible to break it at around 62,000 lb. per sq. in., this high strength being due of course to the cold working on the plate during the test; and the strength of the weld, referring to the original strength of the plate, was therefore at least 125 per cent. With this method of construction the plate would break outside of the weld every time.

As to Mr. Montgomery's question, he would say that in making a flash weld some of the dirt squeezed out and the remainder was held, just as in fusion welding. The metal not squeezed out, which was back of that squeezed out, was still as effective as before. The non-metallic impurities were washed from the V by the metal flowed over the surface of the V during the welding process, and were distributed. There was a certain amount of the metal back of the welded part that was not quite welded, and the impurities distributed themselves by gravity over that section and into the V, adding to the welding material.

Discussion of Mr. Speller's Paper on Steel for Forge Welding

H. V. Wille,[8] in a written communication presented by S. G. Child, said that he had written to a large number of welded-tank manufacturers with the view of determining the present actual practice in this industry.

From the replies received it was evident that a large part of the pressure-tank practice of the present time was based on the use of ordinary grades of boiler and tank steel having a tensile strength of 55,000 to 65,000 lb. and governed by the specifications of the American Society for Testing Materials, the Association of American Steel Manufacturers, or the American Railway Association, which were practically identical and which called for rigid chemical and physical tests.

Some manufacturers were using a softer grade of steel for welded tanks with satisfactory results. This grade was equivalent to the A.S.T.M. specification A–78–21–T.

Mr. Wille believed that both of these grades of steel should be permitted for welding practice. While a number of experimental tests had been made to show the superiority of soft steels over the standard grades for welding, the cases were more or less special and were not representative of general tank practice. It was probable, for example, that welds made by the electric-resistance autogenous process without adding additional metal, should be restricted to a soft grade of steel as had been found desirable in the forge welding of steel pipe, which was lap-welded and had no metal added.

In the oral discussion following the reading of Mr. Wille's communication, questions were propounded to the author by Messrs. John A. Stevens[9] and S. F. Jeter,[10] which he dealt with in his closure.

Replying to Mr. Stevens as to the way a hammer test should be made, he said that in the case of boiler tubes a 2-lb. hammer was formerly used by his company, a pneumatic hammer being later developed on account of the danger to the operator in using a hard hammer. For large forge-welded tubes they had not yet arrived at any set standard. Anything that would not make an impression on the steel but would send a vibration through the cylinder was sufficient for the purpose. It was possible to apply static pressure to a welded vessel almost up to the rupture point without causing a fracture or even a leak. But if the vessel were struck a sudden blow, even with only a 2-lb. hammer, the vibration would carry 8 or 10 ft. from the point of impact, and that would be enough to increase the pressure and disturb the equilibrium, and cause the tube to crack.

As to the objections he had to the Code, he would say to Mr. Jeter that it was incomplete. It should state more than the minimum tensile strength: he noticed that in one place it called for 47,000 lb. and in another, for 45,000 lb., and he thought that 47,000 lb. minimum was enough and would cover the steel ranges that could be used in this connection from 47,000 lb. to 57,000 lb., as specified for "Grade A," on page 7 of the Code. The present Code requirements should be modified if welded steel is to be allowed.

Mr. Wille had asked, why not use flange and firebox steel? It was rather unfortunate that such a widely used grade as the latter should be just a little high in tensile strength, 0.15 to 0.25 carbon being just outside of the range required for good welding. It was, of course, possible to weld it, but the Boiler Code Committee wanted a material that could be welded with the least difficulty, and in spite of the inconvenience of adding another grade of steel, it would be better to have one that had been developed and shown adaptable especially for forge welding. This would be a steel of not over 0.15 carbon. Another grade not over 0.20 carbon might be added to satisfy the demands of those who wanted higher tensile strength, at least for tank cars, and that would include about half the range of the firebox steel. Mr. Wille's problem was somewhat simpler. His company used forged welds on locomotive firebox boilers for the sake of lightness and employed flange steel; all of these welds were reinforced by straps, so that the weld was not depended on to any great extent for strength.

Discussion of the Paper by Professors Fessenden and Bradford on Tests on Welded Cylinders

S. W. Miller[1] wrote that he did not believe it was good practice to heat the shells and the heads of pressure vessels in an ordinary forge fire where the flame was strongly oxidizing, and where it was impossible to keep dirt out of the weld. Even with the best facilities it was difficult enough to keep the mill scale from being included in such a weld, and the chances were that there would be defects in spite of the best practice. The results shown in the paper indicated clearly the difficulty in making a sound weld under the unsatisfactory conditions employed.

The gas-welded tanks apparently had had all the seams welded without beveling, and the heads had apparently been welded to the shells without removing the scale left by the cutting torch.

In the case of the pipe tanks the shell was much thicker than the head, in addition to which the head was beveled, so that the bottom edge of this bevel became hot and ready to weld before the shell did. The result was that there was a great chance of the shell not being brought to the fusion point and the melted weld metal not

[7] Construction, Industrial & Production Engineer, Detroit, Mich. Jun. Mem. Am.Soc.M.E.

[8] Asst. to Vice-Pres Baldwin Locomotive Works, Philadelphia, Pa. Mem. Am.Soc.M.E.

[9] Construction Engineer, Lowell, Mass. Mem. Am.Soc.M.E.

[10] Chief Engineer, Hartford Steam Boiler Inspection & Insurance Co., Mem. Am.Soc.M.E.

being fused to the shell. This was true wherever one piece was thicker than another.

His experience led him to believe that it was not possible to get sound welds in this way. A single V weld was liable to be imperfect under the best conditions, although when properly made in soft plate of good quality with the proper welding wire, it was possible to bend such a weld backward without rupture, the bottom of the V being on the convex side. This was the severest test of a single V weld that he knew of, and every condition must be exactly right for it to be successful. The effect of imperfect fusion along part of the V appeared to have been considerable in the case of the longitudinal seams as shown by Fig. 28 which showed a reinforcement of probably 50 per cent of the plate thickness. Assuming it at this figure and using the formula for eccentric load stresses given in Kent's Handbook it would appear that the maximum fiber stress with a perfect weld would be about 56 per cent more than the average stress on the plate section. If the weld were imperfect, the fiber stress would increase beyond this very rapidly, and the vessel might easily become dangerous.

Cylinder No. 2 was tested to a fiber stress much above the yield point, as shown by the permanent set in Par. 28, and the results of the tensile strength in Table 3 should be taken with some caution especially since the yield points were so close to the ultimate strength. Apparently the figures given represented the strength of the material after it had been once stretched, and were not the real characteristics of the material before testing.

Recommendation (*f*) under Par. 69 for overcoming the defects noticed in the gas welds certainly should be always carried out.

It was very doubtful if the increase in grain size alone had much to do with the strength of the material, although in connection with non-metallic impurities it might be a prolific cause of weakness.

The entire paper showed the necessity for the adoption of better practices, which would doubtless be done as soon as it was fully realized by the manufacturers of tanks that some of the practices at present in use were not safe.

G. O. Carter[11] said that the man who subjected a vessel to a pressure of 200 lb. that was intended for only 100 lb., was at fault. The weld was almost always blamed if there was a failure, no matter what the real cause might be, and especially so if the vessel was made of low-carbon steel. He did not believe that makers of steel welds would suffer, however, if tanks failed outside the weld. As to correct design, he believed the convex head should be employed instead of the concave, in order that the strain should be tensile.

There were advantages in using double V welds, for with the single V there was an unbalanced load on the weld, and his company had found that nothing was gained in reinforcing a weld more than 15 per cent. There were some places where a double weld could not be made, but the circumferential welds required only 15 per cent more than in the case of longitudinal seams and they were a large additional factor of safety.

In welded construction it was possible to obtain more than 100 per cent of the deposited metal or of the base metal, but in riveted work 100 per cent could not be reached. Especial attention should therefore be given to the correct depositing of metal, and the use of low-carbon filler rods should be done away with, in spite of the fact that they were easy to work and easy to clean.

George Bird[12] spoke in approval of the double V weld and said that in experiments his company were conducting the V's on the inside of the vessel were made two-thirds the capacity of those outside. In his section it was difficult to set uniform plate from the mills. He had seen tank plate so stiff that it could not be bent and which was as hard as high-carbon steel.

F. N. Speller[4] protested against the conclusion of the authors that forged welds in cylinders were much inferior to acetylene or electric welds. For 25 years, he said, ammonia containers with dished heads had been forge-welded, the heads being of the same thickness as the shell. Failure, when it occurred, was by reversal, which would open any sort of weld. Forge-welded cylinders made under the I. C. C. specification No. 4, when tested rarely failed at the weld, however, and it was almost an unknown experience to have a dished head reverse itself.

S. F. Jeter[10] said that insurance companies were more willing to accept risks on forge-welded than on autogenously welded vessels although they considered the latter to be reasonably safe. He differed with Mr. Carter as to the use of convex heads for the reason that heads dished inwardly were better fitted to resist the stresses up to some point near rupture. The companies were not particularly interested when the weld had begun to fail.

John A. Stevens[3] closed the discussion by saying that the session had been without doubt one of the most important meetings ever held to consider welding problems. The end in view, of course, had been to obtain information as to the best materials to use for the various classes of work in order that standardization might be effected. A matter that he would like discussed was that of preheating the plates.

General Discussion

The meeting being thrown open to a general discussion of welding, Chairman Fish said that the reason for having delayed so long in getting out the unfired-pressure-vessel code had been primarily the uncertainty as to what the provisions covering welding should be. The demand was insistent for a code, and the Sub-Committee of the Boiler Code Committee sincerely wanted the best advice it could get, and was particularly desirous of getting as much real data as possible regarding construction.

C. W. Obert[13] read an extract from a letter written by Augustine Davis, Jr., president of the Davis Welding and Manufacturing Co., Chicago, in which Mr. Davis said that from his rather extended experience in welding he was certain that almost any class of pressure vessels could be welded if the proper construction was used, without any greater danger, in fact, with less danger than in the use of rivets or other mechanical means. For instance, pulp digesters, ammonia condensers for ice plants and stills for oil refineries were lap-welded. Ammonia condensers were at present and had been successfully oxy-acetylene welded. In fact, he understood they had been more successfully manufactured this way than by any other method. While failures had been made on oil stills and pulp digesters, yet there was no reason why these should not be oxy-acetylene-welded to even better advantage and more safely than by lap-welding except lack of experience and time for manufacturers to develop welding for these purposes.

J. O. Leech,[14] discussing the qualities of base metals, said that tank steel from the steelmaker's standpoint was any grade of steel that would bend or could be fabricated readily. It did not have any definite chemical or physical properties. Some railroads used very soft steel for locomotive fireboxes, while others used a medium grade. The Pennsylvania Railroad had reported that they obtained the best results from steel of 55,000 to 65,000 lb. tensile strength. Other roads wanted 45,000 to 55,000 lb. He would impress on those present that grade did not make quality, and quality did not make grade.

Professor Roark[15] said that there would be no tensile stress on the head joint of a cylinder, unless the head was of the same thickness as the shell and truly spherical, with the same radius as the shell. There seemed to be a general impression that a rounder head, convexed outwardly, would lead to additional tensile strength only on the joint, but analysis would show that such was not so.

S. W. Miller,[1] replying to Mr. Steven's request for information on protecting plates, said that this while procedure of itself would not make a good weld, it would nevertheless tend in that direction because it permitted the use of a smaller tip which did not blow the metal away, and in the case of an electric weld it would enable the welder to get better fusion with somewhat less current. It was hard on the operator with the temperature, say, 100 deg. in the shade. There were those who insisted that preheating was necessary to avoid destruction in circumferential seams, but from his experience he felt warranted in opposing this view. After-heating was no more necessary than preheating except in the case of forge welds, where it was good practice to anneal sufficiently to remove the stresses due to hammering.

F. N. Speller[4] said that with respect to forge-welded vessels, where the welds were heavy it was preferable to anneal the whole vessel to relieve the internal strain.

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[11] Union Carbide Company, New York, N. Y.

[12] Bird, Potts Company, Atlanta, Ga.

[12] Secretary, A.S.M.E. Boiler Code Committee. Mem. Am.Soc.M.E.

[14] Carnegie Steel.Co., Pittsburgh, Pa.

[15] Asst. Prof. Mechanics, Univ. of Wisconsin.

Compounding the Combustion Engine

Interesting and Valuable Discussion of Paper Presented by Elmer A. Sperry at the 1921 Annual Meeting of the A.S.M.E.

IN a paper presented at the 1921 Annual Meeting of the A.S.M.E., Elmer A. Sperry set forth the results of his work, extending over 30 years, in developing a successful compound combustion engine. Such engines are light compared with the normal Diesel engine, being in special cases, according to Mr. Sperry, less than one-tenth, and in some cases less than one-twentieth, the weight for the same output. A high mechanical efficiency and a distinct gain in overall efficiency from fuel to shaft were reported in the paper, as well as a very definite gain in simplicity, direct performance and smoothness of crankshaft diagram—all achieved while adhering to the best practice, namely, four-cycle operation.

Mr. Sperry's paper, slightly abridged, appeared in the January, 1922, issue of MECHANICAL ENGINEERING, which went to press before it was possible to prepare an adequate abstract of the valuable discussion it drew forth. Such a résumé, however, is now printed below and should prove of great interest to those who read or heard the paper presented. The figure numbers above Fig. 8 refer to the complete paper, and not to the abstract published in the January issue.

ORAL DISCUSSION

In opening the oral discussion, George A. Orrok[1] called particular attention to the transfer valve between the high- and low-pressure cylinders, which in Mr. Sperry's engine is the solution of a particularly severe problem. He emphasized the importance of mechanical atomization of fuel, which has proved so successful when using fuel oil under boilers. He also drew attention to the fact that the engine in question followed the accepted canons of steam-engine design.

Francis Hodgkinson[2] pointed out as important the increase of size of the compression space, which leads to detonation and is a remarkable aid to good combustion.

A number of questions were asked of the author by others present at the session, as to the efficiency of the engine, to which he gives attention in his closure.

WRITTEN DISCUSSION

J. C. Shaw[3] submitted an extended and searching written discussion, the greater part of which follows.

DISCUSSION

Mr. Sperry's engine is interesting, as well as ingenious, particularly in the methods employed in effecting the idea of compounding the oil engine, and he is to be commended for his research along the lines indicated.

It would appear on casual observation that there might be some saving in weight over the simple engine, due to the low-pressure element of the compound engine having twice as many working strokes as the corresponding part of the four-cycle simple engine. This advantage, however, is evidently more apparent than real, as will be shown later, provided the same general construction is adhered to for either engine. A similar argument has been frequently advanced for the two-cycle engine over the four-cycle for effecting weight saving, but which has not always proved correct in actual service conditions.

The claim for inherent superior economy of the compound engine over the simple engine, wrote Mr. Shaw, is to be seriously questioned and it is particularly to be regretted that the author has failed to supply any actual figures for fuel consumption to substantiate this general claim. The parallels that have been drawn with other types of machinery, as reasons for anticipating the better efficiency, are incorrect as a rule, and more or less misleading.

The compounding of the steam engine is cited, but this (as is well understood) is done entirely for another purpose, that is, to prevent the condensation and reëvaporization of the medium in the cylinders.

The author similarly makes mention of the large expansion in a steam turbine as a reason for greater expansion desirable in the oil engine, but the comparison is again incorrect. The turbine must work down to a very low absolute pressure, and the final specific volumes handled are accordingly very large. The turbine, furthermore, is not handicapped by having restricted exhaust openings. In the oil engine the back pressure cannot be less than atmospheric pressure, large expansion ratios not being required, and there must be some "toe loss" in card area, or slight pressure drop, so as to get the gases through the exhaust valves, which are limited as to size.

The author also cites the multi-staging of the air compressor as a parallel reason for doing the same in an oil engine. This is primarily done to permit of intercooling the air to reduce the amount of external work required to be done on the air. Any loss of heat in oil engines, either during expansion or compression, beyond keeping the temperatures within practical limits, conversely is to be avoided.

The author further advances the claim for superior economy by "hanging on to the pressure in the gases throughout two strokes,

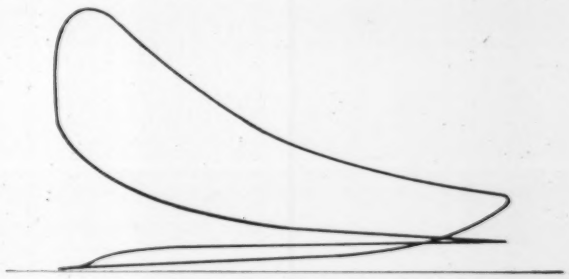

FIG. 1 INDICATOR CARD FROM PORT ENGINE OF MOTORSHIP *William Penn*

clear across the card twice, thus extracting much more of the power they contain." This is difficult to comprehend, as the pressure in either the compound or simple engine should follow the same general adiabatic curve of expansion, due to the burnt gases being composed of the same constituents of combustion. In the formula PV^n = Constant, for adiabatic compression or expansion, the exponent n for air is 1.403, and for exhaust gases is usually taken as 1.37. To sustain or "hang on to" the pressure more during expansion as suggested, would have the effect of lowering the exponent below 1.37 and to approach the isothermal curve in which the exponent becomes unity. This would be undesirable, as it would indicate after burning and loss in efficiency. In the theoretical thermodynamic formula for thermal efficiency, the efficiency varies directly with n, and the pressure should fall rapidly enough to approach ideal adiabatic expansion. It also follows that with the adiabatic expansion less expansion ratio in cylinder is required, and should not be carried beyond what is practically necessary. The high-speed engine, especially working on the constant-pressure cycle, is prone to after burning and raising the end of the expansion curve, and the back pressure is also augmented by the choke in the exhaust valves, in itself due to the high speed. On the other hand, in the slow-speed engine the burning is much more complete in the beginning of the stroke, due to the time element being longer, and there is less restriction in the exhaust passages than with the high-speed engine.

The author shows in Fig. 2 a theoretical card of a two-cycle Diesel engine with exaggerated "toe loss," and indicates in extended dotted lines the additional area which is supposed to become available with the compound effect. In contrast to this card there is reproduced in Fig. 1 on this page a tracing of an actual card taken from the port engine of the motorship *William Penn*. The cylinder size is $29^1/_8$ in. diameter by $45^1/_4$ in. stroke, and the m.i.p. of the

[1] Consulting Engineer, New York, N. Y. Mem. Am.Soc.M.E.
[2] Chief Engineer, Westinghouse Elec. & Mfg. Co., Lester, Pa.
[3] Turbine Engr., Wm. Cramp & Sons Ship & Engine Building Co., Philadelphia. Mem. Am.Soc.M.E.

sard shown is 5.9 kg. per sq. cm., corresponding very closely to the normal rated power of the engine when turning at 115 r.p.m. The end of the expansion curve is about $1^1/_2$ kg. per sq. cm. or 22 lb. This curve has been extended in dotted lines by calculation to half the above actual release pressure, should it be possible to work to the lower pressure, and the additional area that becomes available is found to be less than 6 per cent. This would necessitate increasing the expansion ratio by about 27 per cent with the additional weight and friction of parts involved, and it is accordingly extremely unlikely that any improvement in efficiency could actually be realized with the greater ratio.

An actual card is given in Fig. 12 for the 7 by 11-in. engine, working on the explosion cycle. By comparing it with the constant-pressure card in Fig. 11, it is assumed that the scale is about 360 lb. to the inch, as usually employed. On this assumption the maximum pressure would be about 600 lb., and the compression pressure about half this, or 300 lb., which later is sufficient for automatic ignition with solid injection. The back-pressure line of the high-pressure exhaust as well as the air-charging line is also shown on this card, but it does not follow, as one is lead to assume, that the corresponding pressures registered outside the cylinder will be the same. It would have proved very interesting had corresponding actual cards been taken from the low-pressure cylinder, top and bottom, and had the pressures so obtained been referred to the low-pressure cylinder, as in steam practice. This would show the actual card-area losses due to pressure drops between the various cylinders, as is to be expected. It is to be noted from the high-pressure card given that the negative work of the supercharging side of the low-pressure is actually about equal to the work done by the working side, taking into consideration their relative areas as shown in engine section, Fig. 14. It would appear that at small fractional powers there is danger of overexpansion, and of the low pressures doing very little work and acting as a drag on the system. The engine differs from a compound steam engine in not being able to vary the "cut off" of the low-pressure for equalizing the powers and expansions between cylinders to suit the actual conditions.

The author, however, has furnished us with some ideal cards shown to small scale, Figs. 3 to 8. Comparing cards 5 and 6, showing high-pressure cylinder theoretically functioning both as constant-volume and constant-pressure cycle with same compression pressure, it is seen that the compression pressure is about 650 lb. and the explosion pressure for the constant-volume cycle is over 1000 lb. This is estimated from point B, given as 113 lb. The increased theoretical efficiency of the explosion card is readily understood from the theoretical formulas, and is on account of the greater card area available in common with the high maximum pressure employed. It is seriously doubted, however, if the theoretical card could be anywhere nearly approached in practice, especially in the larger commercial sizes. This is on account of the high shocks and strains that would be produced and the heat troubles encountered within the high-pressure cylinder and transfer valve, but not so evident in the small experimental engine of small dimensions.

Mr. Sperry strongly advocates his high-pressure explosion engine for cargo-ship propulsion for replacing the present well tried slow-speed direct-drive engine. The latter, though acknowledged by him as being responsible for the present high standard of the motorship, he particularly criticises for its excessive weight. In so doing he has overlooked completely the shortcomings of the explosion engine and high-speed engine. The explosion engine is inherently unsuitable for marine drive, due to the shocks at dead center and lack of flexibility at reduced powers. The slow-burning engine, on the other hand, is specially adapted by lack of shock and by great flexibility, due to having the burning take place after the piston passes dead center, without any appreciable rise in pressure.

To prove his point for saving in weight the author mentions a mean effective referred pressure of 300 lb. for the high-pressure cylinders. This has been doubled or referred to one high-pressure cylinder only and increased to 660 lb., and it is pointed out that this is ten times that usually employed in the simple engine. From this he infers the weights, respectively, should be inversely in the same proportion. The comparison of mean pressures would be more nearly correct had that of the compound been referred to the low-pressure cylinder, and which in the case of 1 to 10 engine, would have brought it down to that of the simple engine. The comparison of this high-speed engine on a weight basis, without taking into consideration the additional weights of the complicated clutches and gears also involved, with that of the slow-speed direct-connected crosshead engine is considered very unfair. An attempt has been made by the writer to arrive at a true comparison between the particular compound engine and a simple engine of similar construction. In a contemporary copy of the Sperry Company's publication, the *Sperryscope*, there is shown in outline an engine having the same general overall dimensions as shown in Fig. 14, and designed for the same r.p.m., namely, 400. From this it can be assumed that the engines are one and the same. The engine illustrated in the publication is direct-connected to a 50-kw. generator, and the statement is made that two engines placed end on end are suitable for driving a 100-kw. generator. Acting on the above clue and suggestion made, a tandem compound engine, has been laid down from Fig. 14, and to the same scale has been drawn a Burmeister and Wain auxiliary engine, designed for the same r.p.m., and for direct connection to the same size of generator. This engine, which is a new type, designed with the idea of installing in limited spaces, is four-cycle, totally enclosed, and has three cylinders of $11^3/_{16}$ in. diameter by $13^3/_4$ in. stroke. The diameter of the low-pressure cylinders of the Sperry engine is figured from the 1 : 10 ratio as 22 in., and the high-pressure cylinders are 7 in., as given, by 11 in. stroke.

The simple engine was found to have about 55 per cent less cubic displacement than the compound, which figure does not take into consideration the supercharging displacements of the low-pressure cylinders, but which are essential accessories to the high-pressure cylinders. There are three working cylinders as against six, and one set of sizes of parts instead of the two sets required for the compound arrangement. The compound engine, furthermore, has a larger number of objectionable automatic suction valves, inaccessibly located, and the trunk type of air piston is a type of construction to be avoided, having been abandoned by most two-cycle builders as unsatisfactory in operation.

The weight of the standard Burmeister and Wain engine, including attached piping, grating and flywheel, and as heretofore built, is 350 lb. per s.hp., and not 450 lb., referred to by the author in error, and it should be added here that, by a newer construction, the weight is actually being reduced by 10 to 15 per cent below the 350 lb.

The actual fuel oil consumption on the above standard Burmeister and Wain engine, as used with twin-screw vessels, is from 0.38 to 0.39 lb. per b.hp. With oil of 19,000 B.t.u., and with the new special slow-speed engine, adapted to single-screw vessels, the consumption is about 0.02 lb. lower. It is thought that these figures will stand comparison with any that may have been obtained with the compound engine, though not given in the paper.

In Fig. 17 is shown by the author a 1550-i.hp. Burmeister and Wain marine Diesel engine, coupled to a generator in the background, and which appears small due to the effect of perspective. The author states that the generator so shown (but used for test purposes only), "forms the full load of the engine." He has been misinformed, as the generator in question is used for absorbing only the power of three cylinders at a time of the particular engine, with the other three cylinders acting as additional load.

Author's Closure

In closing the discussion, Mr. Sperry wrote substantially as follows:

Mr. Orrok and Mr. Hodgkinson have touched on a very vital point. The transfer valve has been a stumbling block ever since the first compound was conceived, and every one has realized it, except Junker, who must have "slipped a cog" when he tried to uncover a valve at about 2700 deg. fahr. temperature. But such are the temperatures to be coped with.

The air injection of fuel mentioned by Mr. Orrok is most interesting. If air is compressed to the point required in the Diesel cycle, we get a temperature of about 1200 deg. If this air is compressed again to another 500 lb., which is the regular pressure of the air when it is used, there results another great increase in temperature. When this air is injected into the cylinder, that temperature drops back again, creating a tremendous refrigerator effect just where a refrigerator cannot be allowed. The incandescent

air must not be refrigerated; all the heat must be left in it. It ought to be guarded still further, because it has been calculated that the amount of heat taken up in the vaporization of the fuel is 80 per cent of the heat in the air.

As to the efficiencies, it can be said that they approach more nearly the theoretical air cycle efficiency than any engines that have ever been built. In Italy, a 7 by 11-in. Diesel engine, which is the size of the engine shown in the paper, without the low-pressure cylinder, running at 450 r.p.m. was found to give 13 hp. per cylinder. If this engine were to run at 400 r.p.m., the speed of the Sperry engine, it would give about 22 hp. in the two cylinders. In the Sperry engine, with these two cylinders and the low-pressure cylinder, we have 220 b.hp. It has been run a great many hours at 180 b.hp. This is about seven times as much power as the Diesel engine. But there is not seven times as much machinery operating, simply one more piston. Cards have been taken repeatedly from the Sperry engine to check up the mechanical losses and these are about 10 per cent. In larger engines, between 40 and 50 per cent thermal efficiency at the shaft is anticipated.

Now, as to large engines. What are the limitations on Diesel engines today? They are cylinder size and thickness of cylinder wall. It is impossible to go much above 1¼ in. in thickness of cylinder wall, nor much above 30 in. in diameter. With this in view and with 29-in. cylinders running at 800 or 900 ft. piston speed, and leaving only four of these combustion cylinders in line, the layouts indicate that an 8,000-hp. engine would be obtained. With six combustion cylinders in line, this would be 12,000 hp. So there is no trouble about the size. Dr. Lucke, of Columbia, has been good enough to say that the compound has solved the problem of making large oil engines.

Mr. Shaw falls into the almost universal error in visualizing combustion engine compounding. He takes a normal Diesel card of the *William Penn* engines and extends the expansion down to one-half of the usual pressure at which the exhaust valve opens, hoping thereby to set forth a convincing argument against compounding. What he actually succeeds in doing is to produce a real case of what he characterizes as "toe loss." In applying this expression to Fig. 2, he seems to have overlooked such an insignificant point as the line *XY*. The difference between the two propositions is as great as that between the poles. It is just this attempt to do low-pressure work in a high-pressure cylinder that is condemned and has been the compelling reason for adoption of the compound principle in steam as well as combustion engines.

Were this all we did in compounding, however, it would be even more useless than Mr. Shaw states it to be. He seems to think that the only gain in weight we have is the double use of the same low-pressure cylinder for two combustion cylinders "provided the same general construction is adhered to," etc. But isn't this begging the question? Is the same general construction adhered to? Hasn't he missed several other points, such as the compound combustion cylinder being enabled to handle a great many times the weight of air compared with the simple Diesel—not only many times the weight of air, but many times the fuel with more complete combustion than in any simple engine? Again, the point of very great gain in chilled perimeter and surface per unit volume of the power gases. A number of other definite differences between the compound and simple engine, it is felt, are quite completely set forth in the paper.

The expression "back pressures" appears at several points as being the great argument against compounding. A compound engine of any kind invariably develops back pressure on the piston of the next higher stage. All of these facts have had to be considered in compounding steam. In the early history of this earlier art all of these objections were doubtless dragged forth with many others, groomed and arrayed in opposition to the unthinkable change from simple to compound. Now, as a matter of fact, not, only have none of these features been found prohibitive, but they have been so minimized as not even to be serious, and this has been the proceeding in the present instance.

With reference to the comparison made between Figs. 5 and 6, where the constant-volume and constant-pressure cycles are shown doubt is expressed if the theoretical card is anywhere nearly approached in practice. It is believed that Fig. 12 is an answer to this.

The predictions as to shocks, strains and heat troubles are on a par with many other of the imaginary troubles. The facts are there is nothing that approaches shocks in the high-intensity burning shown. The very time factor that so alarms Mr. Shaw carries with it its own remedy in relation to its actual effect on the heat gradient and heat losses. Mr. Ricardo of England has evidently gotten sight of this phase of these interesting phenomena.

There is no lack in the flexibility of the engine employing the high-intensity burning card.

With reference to the comparison of the compound with the simple engine, inasmuch as there is no such thing as a previous compound combustion engine to compare with, the author is perfectly justified in referring all of the mean effective pressures back to the only thing that previous engines do have, viz., the combustion piston area, and the evident value in securing ten times the net mean effective pressures to the crank for each fuel injection, together with a very much better distribution of the power application to the crank from any single injection, it is felt needs no further emphasis here.

In connection with the generating sets referred to in the *Sperryscope*, the author cannot agree that the engine that is lighter than the standard General Electric or Westinghouse generator to which it is directly coupled is not exceptional, especially considering that this applies to the ordinary run of engines, designed with no thought whatever of lightness. Fortunately it is not necessary to compare the compound with other than trunk engines to bring into strong contrast the gain in weight. There are large numbers of these engines in service running between 150 and 350 lb. to the b.hp., many of them running at much higher piston speed than the comparatively low piston speed of 735 ft. employed in the Sperry 7-in. engine. However, when employing the same class of refinements as used in submarine engines, the weight comes down to a very low figure, as indicated in the paper.

A point not emphasized in the paper is that in the compound much larger power units can be made in trunk engines than possible with simple engines, the controlling factor covering this point, as is well known, being the relation of combustion piston and the wrist-pin bearing diameters. This gain follows from the fact that a given combustion cylinder in the compound accommodates from four to six times the fuel with a corresponding gain in power for the size. Naturally the alternative of this is that with the compound we do not have to resort to crossheads until we reach four to six times the power of the simple engine per combustion cylinder at the same piston speed and revolutions. It is felt that these are definite gains that cannot be neglected. The crosshead type of engine is just as applicable to compounds as to simple engines. The builders of crosshead engines are driven to adopt this from the limitations given above, whereas so long as excess slipper area is available with ample lubrication, and it shows practically no wear, many of our leading engineers are commencing to believe that the trunk engine is superior, and we know that it is lighter.

With reference to the heavy engines, the author makes it clear that a plurality of unit engines is necessary in a ship, but in all instances twin screws have to be resorted to, where a single screw would be much better all round. It is believed that plural units with their simple slow-speed gears will forge ahead and win the place that they deserve, especially in view of the complete safeguards of the air-gap clutch, which our critic seems to overlook, making the most completely maneuverable ship yet produced.

As to the generator in Fig. 17, this being a photograph of a foreign-built engine and not one of Mr. Shaw's construction, there seems to be doubt as to the accuracy of the author's remarks concerning it. Halfway measures are not usually adopted. A similar photograph of the Maume engines, which are still larger than the one of Fig. 17, where a full-load generator was used to his knowledge, shows about the same contrast. But suppose the statement to be correct. Does Mr. Shaw think for a moment that if the generator shown were to be multiplied in size by the cube root of 2 the contrast between Figs. 16 and 17 would be substantially altered?

If present signs are any indication, it will soon be possible for the author's critics to satisfy themselves as to all points of efficiency and economy of these engines under practical conditions of operation. This, it would seem to the author, should settle all controversial points and while the engines will probably not be above criticism,

(*Continued on page 554*)

SURVEY OF ENGINEERING PROGRESS

A Review of Attainment in Mechanical Engineering and Related Fields

Investigation of Oscillatory Phenomena in Turbo-Generators by Means of a Vibrograph

By DR. JOS. GEIGER

HITHERTO investigation of oscillatory phenomena in high-speed machinery and, in particular, turbo-generators, has been limited to the calculation of the critical speeds at which the shaft begins to exhibit oscillatory phenomena. In the majority of cases only the first or lowest critical speed was determined, but even these limited calculations were often more or less uncertain, because, in the case of shafts located in more than two bearings, the method of supporting the shaft and of holding it in position by nuts, etc., introduces important factors of which we do not know much but which materially affect the results of the calculations. Oscillations not due to the rotation directly but induced by the rotors, housings, foundations, etc., were as a rule not predetermined at all. Because of the lack of proper instruments, observations were inexact and in many cases incomplete, it being entirely impossible to determine without proper instruments the magnitude, direction, and frequency of the various vibrations, particularly where they were superposed.

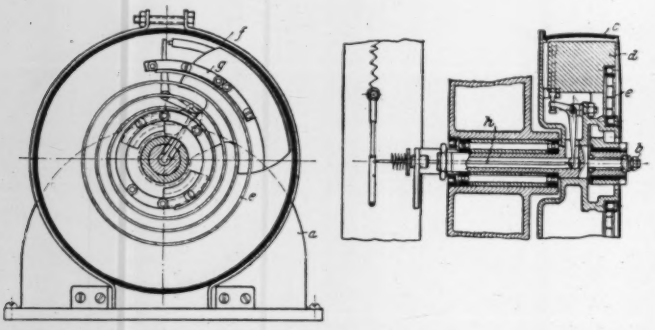

FIG. 1 THE VIBROGRAPH

As long as the vibrations were such as not to imperil the structure they could have been neglected; the author, however, ran into a case where something had to be done. In this case he had to deal with a 10,000-kw. turbo-generator running at 3000 r.p.m. The unit ran very nicely for a while and then powerful knocks appeared in the exciter bearing. A series of experiments designed to discover the cause of the trouble proved to be unsuccessful and it was decided to make use of a vibrograph after the ordinary seismograph proved to be unsuitable for this particular purpose. The vibrograph, Fig. 1, was developed during the war to investigate oscillatory phenomena in high-speed Diesel engines and their foundations. It is based on the same principle as the various seismographs, namely, a properly suspended heavy mass oscillating but not in tune with the vibration of the body under investigation. The relative motions of this latter and the inert mass represent the absolute oscillation of the body under investigation. The difference between the vibrograph and the siesmograph or pallograph, (which latter is something like the seismograph), lies mainly in constructional details and to a certain extent in the method of operation. The frame *a* is set or screwed on to the element under investigation, such as a machine part. It is provided with an axle *b* with housing *c* attached to it, and the inert mass *d*, which is rotatably attached to the axle and connected with it by means of wheel *e*. The axle, clamp, and inert mass can be rotated into any position desired and held by tightening the band *f*. If the insert mass lies vertically under the axle, the device can oscillate horizontally; if it is located at the same elevation as the axle, the device begins to oscillate vertically.

The tension of the spiral spring, which is different in the two cases, is each time so adjusted by shifting or clamping the ring *g* that the scribe lever moves about the central position. Of course, the device can record also oscillations occurring at an angle to the horizontal and may be itself placed at any angle to the ground level so that with the same apparatus one can obtain records of disturbances no matter in what direction they may occur. In this respect the vibrograph is different both from the pallograph and the seismograph, in addition to which the vibrograph has the still further advantage of smaller size and smaller weight, the latter being only 6.5 kg. (14.3 lb.), and the size 200 by 200 by 200 mm. (Say, 8 by 8 by 8 in.)

The relative motions of the inert mass of the vibrograph and the cup surrounding it take place tangentially to the shaft *b* and are converted by two angular levers, first into radial and then into axial displacements; they are then transmitted by means of the needle *h* located inside of the hollow shaft and the needle records them on a paper band driven by clockwork.

As the weight of the vibrograph is only very small as compared with seismographs, its sensitivity and magnification are not as great. While seismographs can record very slight movements, such for example, as are produced by distant earthquakes, the range of the vibrographs begins only with much coarser vibrations and extends over the range of those met with in practical engineering up to, say, displacements in excess of 1 cm. (0.4 in.) and oscillations of the order of frequency of 15,000 per min. On the other hand, the vibrograph is more sensitive and handier to use than the Schlick pallograph.

This vibrograph was used for testing the 10,000-kw. turbo-generator set in which vibration was giving trouble. After some testing at various points on the foundations, it appeared that the best way to get a clear idea as to the vibrations taking place would be to obtain a record of oscillations at the three main bearings (front turbine bearing I, double bearing II, and generator and rear turbine bearing III).

While, in the first place, it was important to measure the vertical vibrations, there were also strong axial vibrations in the neighborhood of bearing III. While the presence of such vibrations may be quite surprising at first glance, as the turbine shaft does not produce forces acting on the axial direction, the explanation of the presence of axial vibrations lies in the fact that bearing III was located not directly over but somewhat off the neutral axis of the cross-beam lying underneath. Because of this, the forces which generated the vibrations in a vertical direction tended also simultaneously to create twisting actions about the neutral axis, which appeared then as powerful axial oscillations. A record of these twist motions by means of a torsiograph proved the correctness of this explanation. Furthermore, the vibration at bearing III was much stronger than either at II or at I, and indicated the presence of resonance, as appears from the vibrograms reproduced in the present article.

The magnification was in every case 10.72 times. While there were reasons to believe that resonance vibrations might be present in this case, the origin was not sufficiently clear, as according to previous observations the first critical speed of the turbine shaft lay around 1650 r.p.m., which was confirmed by the vibrogram. But, according to the statement of the turbine builders, the second

critical speed should have been much beyond 3000 r.p.m. which latter was the operating speed.

The author has therefore determined the natural periods of oscillations of the individual parts of the foundation and machinery and, in particular, the turbine shaft. The vibrograph was also used for this purpose as part of the following simple process. The vibrograph is attached to the part of the foundation under investigation and the paper band is started so that the stylus records a straight line; then a sufficiently heavy weight is suddenly dropped down [65 kg. (143 lb.) from a height of 70 cm. (28 in.) was found to be sufficient in the present case]. The vibrograph records then the vertical oscillations (Fig. 4) of the respective part of the foundation. A similar test with proper modifications will give the horizontal natural period of oscillations of the same and other parts.

The vibrograph was also used to determine the natural oscillations of the turbine shaft, but in a different manner. The vibrograph shaft with its inert mass and cup was removed and instead an angle lever with a second needle built in (Fig. 5). The angle-lever holder

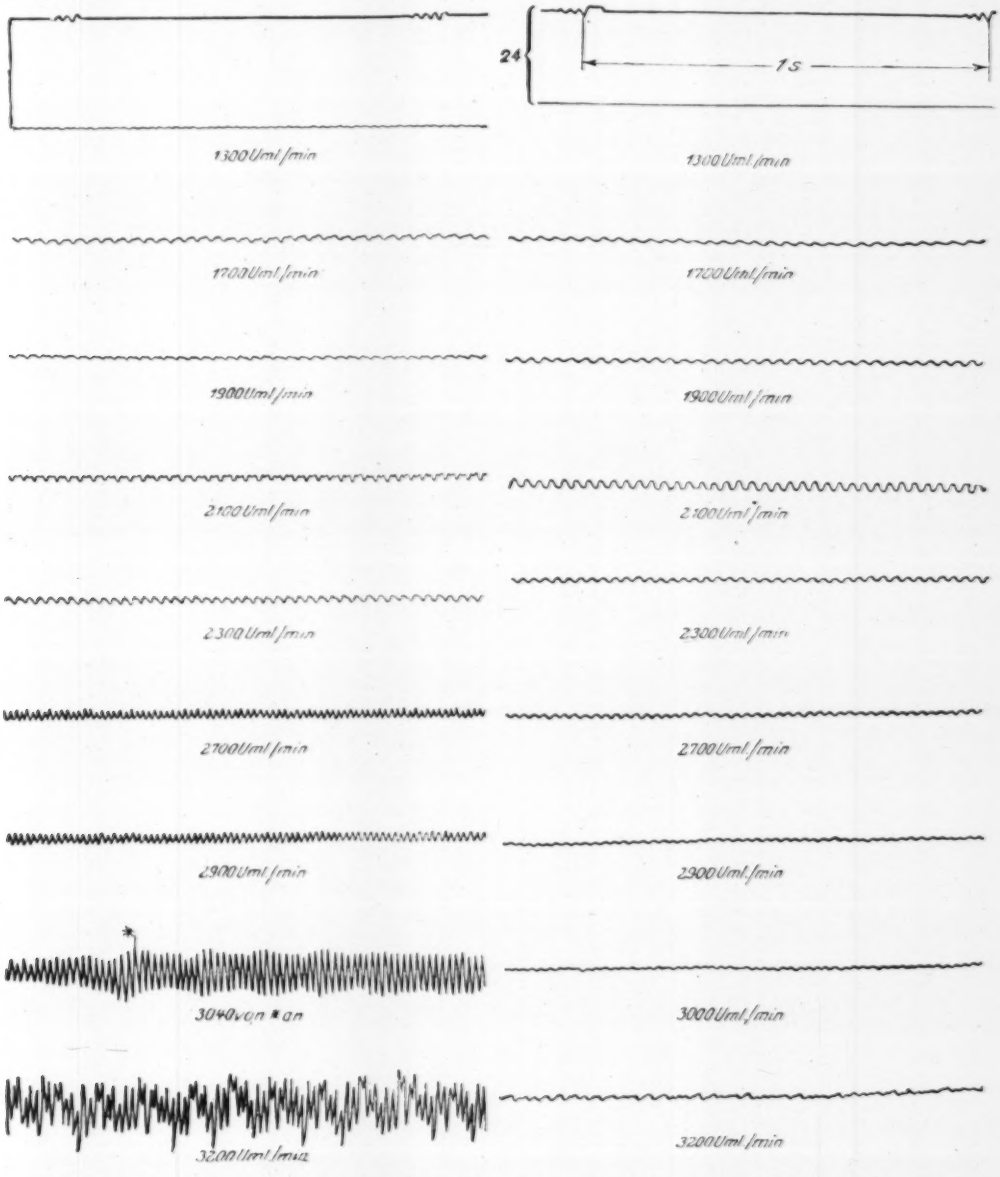

FIG. 2 VERTICAL OSCILLATIONS OF THE GENERATOR BEARING BEFORE (ON THE LEFT) AND AFTER (ON THE RIGHT) REINFORCING THE BEAM UNDERNEATH IT AND ITS TWO SUPPORTS
(*U/ml./min.* = r.p.m.; von* *an* = from* on.)

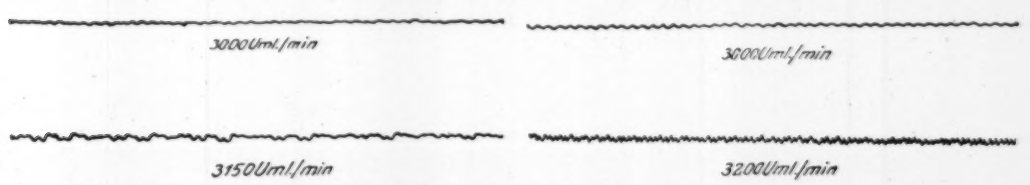

FIG. 3 VERTICAL OSCILLATIONS OF THE DOUBLE BEARING BETWEEN TURBINE AND GENERATOR BEFORE (ON THE LEFT) AND AFTER (ON THE RIGHT) REINFORCING THE CROSS-BEAM AND ITS TWO SUPPORTS
(*U/ml./min.* = r.p.m.)

a may by means of nut *b* be shifted into any desirable position on the bearing. The upper part of the turbine housing was removed and the needle connected with the outer rim of a wheel fitted, after the bearing block of the vibrograph was attached, to the upper face of the bottom half of the turbine housing.

The paper band is then started and a shock given (by a piece of

gas pipe) to the turbine shaft or the hub of the wheel. It is not necessary to apply much force in doing this. The vibrograph records then the natural oscillations of the shaft, from which one can determine their period though not at the lowest level.

The remainder of the article gives further details as to the application of the vibrograph and shows how corrections may be made in the turbine supports by means of the information derived from its use. This part of the article cannot be abstracted owing to lack of space. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, no. 18, May 6, 1922, pp. 437–440, 35 figs., *deA*)

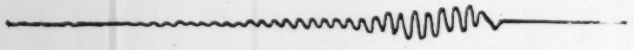

Fig. 4 Vertical Oscillations Due to the Fall of Weight on the Cross-Beam at 9000 r.p.m. Before (above) and After (below) the Foundations Were Reinforced

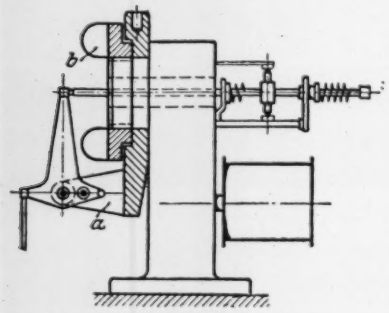

Fig. 5 Vibrograph Altered for Measuring Natural Vibration in the Turbine Shaft

Short Abstracts of the Month

COMPRESSORS (See Refrigeration)

ENGINEERING MATERIALS (See Testing and Measurements)

Formation of Cracks in Boiler Plates

Formation of Cracks in Boiler Plates, Dr. B. Strauss and Dr. Ad. Fry. It would appear that low-carbon steel which has been cold-worked and then heated to a blue heat shows pronounced brittleness when tested at ordinary temperatures, but until lately it has been practically impossible to recognize this brittle condition. The method of etching developed in the experimental laboratory of the Krupp Company, however, makes it possible to recognize the brittleness resulting from blue heat by observing force influence figures.

These force influence bands were discovered not only in old defective boiler plates, but also in new plates after they were heated to 200 deg. cent. (392 deg. fahr.) and straightened in a machine, which means that they have undergone cold working similar to the bending of the plates.

It was noted, however, that these force influence bands did not appear in all soft steels and sometimes appeared only in the zone of high-phosphorus segregation but not in the low-phosphorus surface layers of the plate. Their appearance is therefore dependent on the composition of the metal.

In addition to composition, the temperature at which the plate was finished in rolling is important. Plates which left the rolls fairly dark sometimes showed bands, while plates finished in the rolls at a higher temperature were usually free from the bands.

An important influence on the behavior of the plates is exercised by the manner of their annealing. Plates which were annealed above the transformation point Ac_3 showed force influence lines after bending only in the phosphorus layers, while in plates annealed at a low temperature their presence over the entire cross-section was very pronounced.

Notched-bar impact tests on various specimens have confirmed the original statement that soft steel worked cold or at blue heat is brittle when tested at room temperatures. It has been found, however, that plates, which after bending and annealing are brittle at ordinary temperatures are tough when tested at 200 deg. cent. (392 deg. fahr.), regardless of any previous treatment they may have received.

A supplementary series of warm notched-bar impact tests were carried out. The results of these tests are shown in Fig. 1. The curve shows a rapid increase between 100 and 150 deg. cent. (212 and 302 deg. fahr.), and a sharp turn above 150 deg. cent. Above this temperature the values approach those of the plates annealed at 900 deg. cent. (1652 deg. fahr.).

From this investigation it would appear that boiler material shows in most cases a much higher toughness in the warm condition than in the cold; that the formation of cracks is promoted by allowing the boiler to cool off, and that in many cases cracks are caused by the impact effects when cleaning the boiler or calking it, a result which might be prevented by properly appreciating this condition and taking due care to avoid it. This may explain how microscopic cracks can lead to large cracks during the hydraulic test through the impact effect of the pump stroke, or may lead to an explosion through the breathing of the boiler. (*Stahl und Eisen*, Aug. 18, 1921, pp. 1133 and following; translated in *Forging and Heat Treating*, vol. 8, no. 5, May 1922, pp. 225–229, 23 figs., *et*)

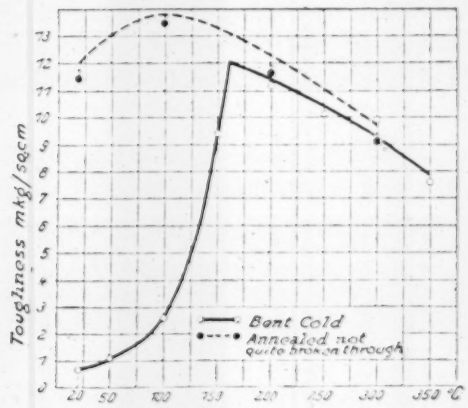

Fig. 1 Warm Notched-Bar Impact Tests on Annealed and Cold-Bent Boiler Plate (45-deg. Notch)

FOUNDRY

Tropenas Converter for Making Steel, S. R. Robinson. The Tropenas process is a variation of the Bessemer intended for making steel in comparatively small lots—one to two tons. The present article applies particularly to practice with vessels of two tons capacity. The process consists in melting a mixture of low-phosphorus pig iron and steel scrap in an ordinary cupola and transferring this metal to a converter in which a blast of air is allowed to impinge on to the surface of the metal. The article gives practical advice as to the carrying on of the process. The following information is given as to the cost of operation.

Assume a charge of 60 per cent pig iron and 40 per cent steel scrap; also a combined cupola and converter melting loss of 18 per cent. Then:

Cost of 1200 lb. pig iron	$21.43
Cost of 800 lb. steel scrap	9.40
Total	30.83
Allowing 18 per cent loss, cost per ton	36.38
Cost of 20 lb. ferromanganese	0.60
Cost of 12 lb. ferrosilicon	0.36
Cost of 300 lb. coke	0.90
Cost of repairs	1.00
Cost per ton of steel in ladle, exclusive of labor	$39.24

(*The Blast Furnace and Steel Plant*, vol. 10, no. 5, May, 1922, pp. 282–284, *gp*)

FUEL (See Power-Plant Engineering)

HYDRAULICS

PIPE FRICTION AND PUMP EFFICIENCY, Wm. Brazenall. Tests to establish comparative performance for three types of pumps, namely, turbine, three-throw ram, and differential ram.

The tests are of interest as they are carried out under practical working conditions, and, among other things, indicate the relation between the pipe friction and the pump efficiency. The results are given in the form of tables. One of the interesting features of the article is that it presents the results in units of an electric horsepower and also British monetary units, the intention being to find an economic size of pipe, which, according to the definition given by D. M. Mowat, is such a pipe that the frictional losses may not be greater than the loss of interest on capital used in installing the pipe which will greatly lessen the frictional losses. (*Transactions of the Institution of Mining Engineers*, vol. 63, part 1, March, 1922, pp. 59–69, 1 fig., *e*)

INTERNAL-COMBUSTION ENGINEERING

Airless Injection System for Oil Engines

AIRLESS-INJECTION SYSTEM FOR OIL ENGINES, Edwin Lundgren. Description of results obtained by K. J. E. Hesselman in Sweden, known as the successful designer of the original Polar-Diesel engine. One of the most important features of the new system lies in the design of the fuel valve. After the fuel enters the valve it is forced through a high-pressure filter of a special design. When the fuel pump delivers a certain accurately determined amount of fuel to the valve, the pressure within the valve rises to such an extent that the pressure of the spring (about 4000 lb. per sq. in.) is overcome and the fuel is squirted into the cylinder through a nozzle and a

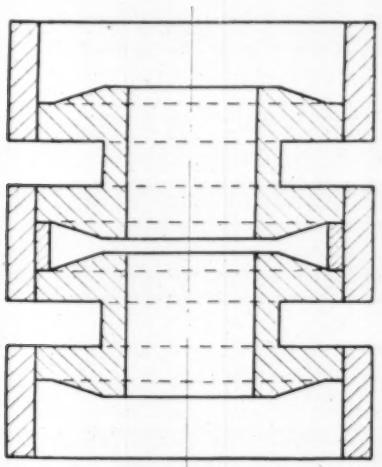

FIG. 2 SPRING ELEMENTS IN THE FUEL-INJECTION VALVE OF THE HESSELMAN SOLID-INJECTION OIL ENGINE

burner provided with a limited number of fine holes arranged in definite manner suited to the form of combustion space.

In spite of the high pressure exerted on the fuel-valve spring it is of very small dimensions. The fundamental idea of the spring was to use the deflection of circular steel disks supported but not fixed at the edges. A mathematical investigation of the problem confirmed by experiments showed that the deflection attained a maximum when the disk was provided with a hole of a certain size, some of the data of this investigation being shown by curves in the original article. The form of the spring element finally adopted is shown in Fig. 2. Two steel disks are united by an inner circular web to a double disk. The spring is built by a number of these spring elements connected to each other by means of shrink rings and separated from each other by annular distance pieces. The tension of the spring is adjusted by means of a nut on top of a valve which forces the spring spindle downward. This spring spindle passes through a packing of suitable material which prevents leakage. Once adjusted the spring spindle is said to stay stationary and there is no trouble in keeping the packing tight.

The motion of the fuel valve therefore meets no frictional resistance. Consequently the lift of the valve is determined solely by the pressure of the fuel pumped or rather by the amount of oil delivered by the pump to the valve. As this amount must be proportionate to the lead, the lift of the valve must also correspond to the same.

Tests described in the original article were made to show the relation between load and valve lift. The fuel pump used in the Hesselman engine is said to be of novel design. It has only one plunger, even if used in multiple-cylinder engines. Consequently it has to run with at least such a speed that its number of pressure strokes corresponds to the number of power strokes of the engine. The amount of oil delivered each stroke is controlled by a common suction valve which is under the influence of the governor and may also be adjusted by hand. (*Motorship*, vol. 7, no. 6, June, 1922, pp. 444–445, 4 figs., *d*)

MACHINE PARTS AND DESIGN

Pulley Design for Steel Belt Drives

MACHINERY DRIVEN BY STEEL BELTS, John D. Knox. Steel bands have recently been produced in America having no joints or welds (Power Engineering Co., Youngstown, Ohio). In the process employed each band is rolled from a section of seamless tubing of special chemical and physical qualities or from other kinds of

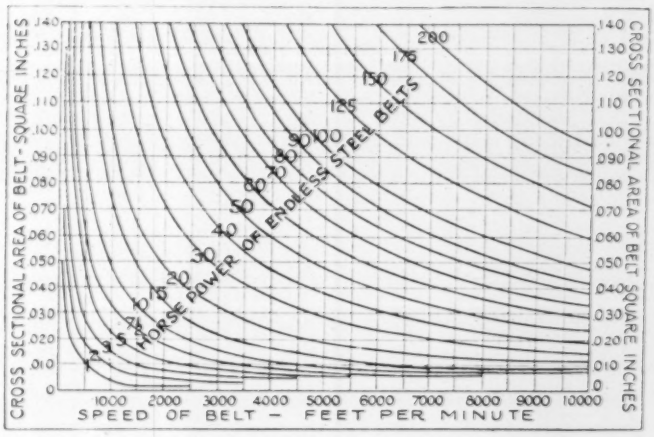

FIG. 3 CURVES REPRESENTING THE HORSEPOWER OF ENDLESS STEEL BELTS FOR VARIOUS SPEEDS AND CROSS-SECTIONAL AREAS

endless rings. The steel belts are made in various widths up to 6 in., dependent upon their ultimate use and the horsepower to be transmitted.

It is stated that the drives to which the steel belt is especially adopted are air compressors, turbines, fans, motor-generator sets, grinding and polishing wheels and high-speed hot and cold saws. The bands can be run from 12,000 to 18,000 ft. per min., provided the pulleys will withstand the centrifugal force. To secure an even distribution of power over the entire width of the steel belt in order that one edge may not be stressed to exceed its breaking strength and thus result in failure of the entire band, care must be exercised in installing the belt. To obtain a linear speed from 10,000 to 15,000 ft. per min. the diameters of the pulleys are increased, which permits the use of a steel belt about half as wide as those running at ordinary speeds. But since the speed is accomplished by an increase in the diameter of the pulleys, it is possible to increase the thickness of the band, which in turn permits an additional decrease in the width.

The relation of pulley speeds to belt widths and thicknesses are such that about a 50 per cent increase in the diameter of the pulleys decreases the width by a half. Therefore, the problem of belt width, thickness, and speed ultimately resolves into one of pulley design. The curves in Fig. 3, which represent the horsepower of belts for various speeds and cross-sectional areas, illustrate this

point. For example, an 8-in. diameter pulley at 1500 r.p.m. has a speed of about 3000 ft. per min. A belt 2 in. wide and 0.010 in. thick will transmit about 13 hp. If the pulley is increased to 12 in. in diameter the speed becomes approximately 4500 ft. per min. and the thickness can be increased to 0.015 in. The sectional area, therefore, can be increased from 0.020 to 0.030 sq. in. The latter belt as shown in Fig. 3, will transmit 28 hp. In other words, the width can be decreased to one-half of its original width. A diagram which is included in the original article shows the proper speed of belts in relation to the pulley diameter and the revolutions per minute and the linear speed of the circumference of the belt in feet per minute.

From actual operation it has been found desirable but not necessary to use large-diameter pulleys, the larger the better within reasonable limits. They may be relatively narrow and lightly constructed. Pulleys which are less than 4 in. in diameter are not desirable.

To prevent slippage and to cushion the belt the faces of the pulleys are covered with sheet cork. This material will stand compression and still recover its original shape; its adhesion to the steel belt as well as the cohesion to the pulley is satisfactory. Since the cork facing is attached more securely to a rough surface than to a smooth surface, the face of the pulley is either turned with a rough cut or roughened with a file, and made flat or with a slight crown. The life of steel belts has not yet been determined. (*The Iron Trade Review*, vol. 70, no. 16, Apr. 20, 1922, pp. 1114–1116, 6 figs., *dp*)

BEVEL-GEAR DESIGN, F. E. McMullen and T. M. Durkan. It has been common practice in the past to use in designing bevel-gear teeth, spur-gear formulas such as those of Brown and Sharpe. The Gleason 0.3 and 0.7 long- and short-addendum tooth was brought out to improve this condition and various other alterations of the standard spur-gear design have been used, but for the most part these can be applied to certain combinations only and therefore are not universal. Recent applications of bevel gearing covering a wide range of ratios have made it imperative that a progressive system embracing all ratios and any number of teeth in common use be worked out. An investigation conducted by the Gleason Works with the idea of developing a practical system of designing the quietest form of teeth consistent with strength and wearing considerations has resulted in a simple table. A system has been developed applicable to any pair of generated spiral or straight-tooth bevel gears operating at right angles where the pinion is the driver and has ten or more teeth. It does not apply to bevel gears cut on former-type planers.

The system is described in some detail. It may be mentioned here that the principal qualities considered arranged in the order of their importance are quietness, strength, and durability. As regards quietness, it has been found that bevel gears cut with a lower pressure angle operate more quietly than those cut with a higher one, other conditions being equal. The basis of the system is therefore the use of the lowest pressure angle which will not sacrifice strength by using excessive undercut. Moreover the selection of a low-pressure angle in preference to a higher one does not necessarily result in a considerably weaker tooth, because the stronger section of the higher-pressure-angle tooth is offset by the greater arc of action with the lower angle. The question of durability is somewhat complicated and is discussed in the original article.

The author expresses the opinion that a standard non-interchangeable system, possibly along similar lines to the one developed for bevel gears, is needed for spur gears. He claims that such a system would be of as great importance as a standard interchangeable system, since a large proportion of spur gears like bevels are intended to operate in pairs only. The concessions made to allow interchangeability are so great that the case of the non-interchangeable gear should be granted as much consideration in the way of a standard system as is given to the interchangeable gears. (Paper before Buffalo meeting, American Gear Manufacturers' Association, abstracted through *Automotive Industries*, vol. 46, no. 20, May 18, 1922, pp. 1064–1068, 8 figs., *pA*)

MECHANICS (See Machine Tools)

MACHINE TOOLS

Experiments on the Action of Cutting Tools

AN ACCOUNT OF SOME EXPERIMENTS ON THE ACTION OF CUTTING TOOLS, Prof. E. G. Coker and K. C. Chakko. Description of experiments made on the action of a cutting tool by the aid of polarized light.

The principle used is described as follows: Nearly all transparent bodies when loaded become doubly refractive, and a ray of ordinary light passing through the material in a state of stress is subjected to a selective retardation whereby its transverse vibrations lag one behind the other. No effect is visible to the eye, since ordinary light consists of such a complex system of transverse vibrations that the eye is unable to detect what is going on; but if ordinary light is, as it were, strained through some kind of sieve whereby a homogeneous character of a particular kind is imparted to it, the effect of stress in the material becomes apparent. The most convenient apparatus for obtaining the homogeneous light mentioned is a crystal of transparent calcium carbonate, cut in a special way invented by an Edinburgh optician, William Nicol.

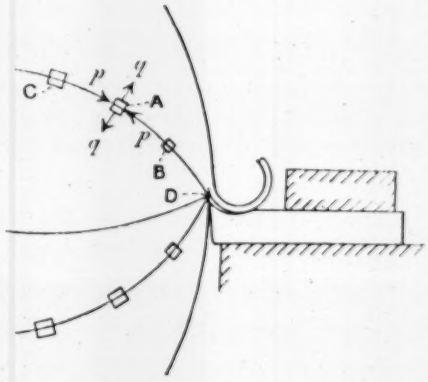

FIG. 4 DISK, THE EDGE OF WHICH IS BEING TURNED UP IN A LATHE

Ordinary light, after passing through such a crystal, is found to execute its transverse vibrations in one special plane, and this unilateral kind of light is usually called polarized light; and although this is not a very happily chosen designation, yet it seems to be so firmly established that it is hardly possible now to replace this term by a more appropriate one.

If a stressed body is placed between a pair of Nicol prisms and a beam of light is passed through the combination, color effects are observed which are due to the fact that the plane polarized light from the first prism is broken up by the stressed material into two sets of plane vibrations of light, which travel at different velocities through the material. Not only do these two systems of waves travel at different velocities, but they vibrate in planes at right angles to one another. The function of the second prism is to select components in some definite plane from these two systems, so that these latter will interfere with one another. Interference between two sets of light waves in the same plane is visible to the eye, when the light passing through the object under stress is projected on to a screen, and if white light is used, brilliant colors of a rainbow pattern appear, and indicate in a particular manner, to be described later, the stress in the material which the light has passed through. It is owing to this effect that an optical analysis of stress distribution in a transparent body is possible.

As regards the condition of the stressed body itself, the authors consider this to be a plate loaded by forces acting in its plane. This is illustrated by reference to an example drawn from the case of a disk, the edge of which is being turned up in a lathe as shown in Fig. 4.

Select any point A in that disk which has a definite and invariable position with regard to the point D of the lathe tool, and imagine a small square placed centrally over the point A, as shown. If this square is set in one particular position, it is capable of proof, as textbooks show, that the stresses at that point in the disk are perpendicular to the edges of the square and are not so for any other angular position. Further, the intensities of these stresses

p and q are such that one is the maximum stress at the point A and the other is the minimum stress at the same point. If by any means it is possible to measure the intensities of p and q and their directions, then it is quite an easy matter to find the stress at the given point in any other direction. The principal advantage of the experiments described here is that both p and q can be measured, and their directions can also be determined at any points A, B and C, provided the law of the optical effect continues to hold. The trial square can, in fact, be moved from point to point, as indicated on the figure, and for each position, the direction determined in which it must be oriented to give stresses normal to its edges. These stresses are distinguished from any others by referring to them as principal stresses, since all others can be derived from them by simple means. It will be convenient here to describe how the directions of principal stress are obtained experimentally by reference to a disk or plate subjected to the action of a cutting tool. For this and all other optical experiments described here, the polarizing and analyzing Nicol prisms are set with their own principal planes crossed at right angles. Now it is an ascertained fact that the two sets of waves into which the stressed body divides the light ray are also perpendicular to each other and the directions of their vibrations are those of principal stress. Light, therefore, is stopped everywhere in the plate where the directions of the prisms correspond to similar directions of principal stress, and a series of black bands can be obtained by simply turning the prisms round until the whole field of view has been covered, each direction being marked from the index plates attached to the prisms.

It will be noticed, when this is being done, that although the black bands move, the colors remain stationary, so that the indications of stress intensity are not dependent on the angular rotation. A set of lines marking the centers of these black bands is shown in Fig. 5-b and the inclination of the stress in both work and lathe tool are marked thereon.

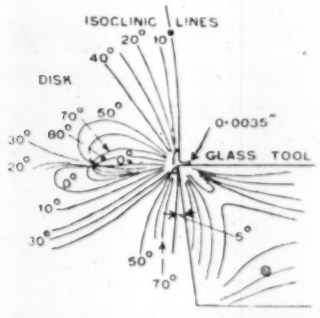

FIG. 5-B

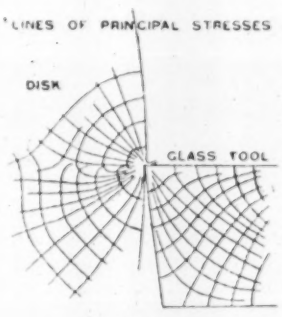

FIG. 5-C

FIG. 5-B LINES MARKING THE CENTERS OF THE BLACK BANDS IN PLATE

FIG. 5-C LINES ALONG THE DIRECTION OF PRINCIPAL STRESSES

This information with regard to directions of stress is complete, since every part of both tool and work is swept over by the black bands during the rotation of the prisms. For convenience, however, it is generally preferable to show this information in a different manner by lines which run along the direction of principal stress. Some of these are shown in Fig. 5-c and are derived from the black bands by a simple geometrical process.

As regards the intensities of the stresses, it is pointed out that the color effect obtained depends on the value of the difference of their intensities at a point and the method to separate such two stresses as p and q, Fig. 4, is described in the original article.

It is said that the color photograph has given a considerable amount of information on the behavior of cutting tools. Thus, in the color photographs very near to the point of the tool an intensely black spot is found which varies slightly in position in regards to the running positions. It forms in part a good qualitative index of the steadiness of the running and of the uniformity of the cutting action. It is also of interest to note that there is a black patch in the shaving immediately above the tool, which remains stationary in time but not in position, as, although the shaving is intensely colored after leaving the tool, the black patch disappears (not, however, with a badly ground tool).

The general appearance in polarized light of a disk under the action of a cutting tool varies with a shape of the tool. Thus, a tool with an edge finished by grinding in the usual way and an angle of from 45 to 60 deg. produces an action quite different from one with a similar edge but finished on a stone as perfectly as possible.

Considerable differences are also noticed with a change of speed when a sufficiently sharp or properly formed cutting tool is used, so that color pulsations are avoided.

The measurement of the stresses in the neighborhood of the tool was not found to present any great difficulty.

Stress distribution in the cutting tool was also investigated, but it does not appear that definite conclusions have been arrived at. (Paper before the *Institution of Mechanical Engineers*, abstracted through *The Engineer*, vol. 133, no. 3462, May 5, 1922, pp. 503–505, illustrated, *d*)

POWER-PLANT ENGINEERING (See Engineering Materials)

Distilling Tar from Coal While Burning Under Boilers

DISTILLING TAR FROM COAL WHILE BURNING UNDER BOILERS. Dr. Alfred Gradenwitz. German engineers are finding it worth while to extract the low-temperature tar from coal used for power and heating purposes. One of the three methods of doing this is by burning the fuel in a grate furnace and distilling shaft arranged to combine the burning and distilling processes. This method has been worked out by one of the engineers of the Pintsch

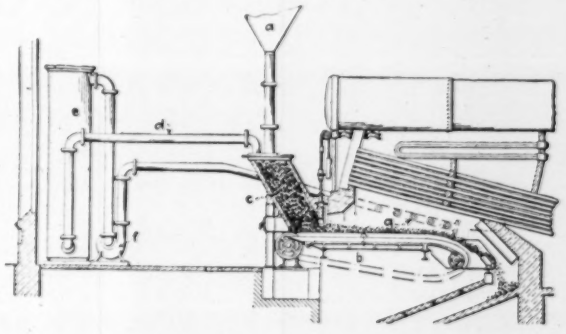

FIG. 6 COMBINED FURNACE AND DISTILLATION PLANT FOR RECOVERING TAR FROM COAL BURNED UNDER A BOILER

Company of Berlin, and employs a type of furnace shown diagrammatically in Fig. 6.

Before the coal in the bunker a reaches the grate b, it passes through a distilling shaft c. The coal in the bottom of this shaft is heated by the glowing coals on the front of the grate, and some of the gases given off are drawn through the pipe d into the extraction plant e by the pump f. The permanent combustion gases are then returned through the burners g into the furnace, the tar, ammonia, etc., having been retained in the extraction plant.

Not all the gases extracted from the coal are drawn through the distillation shaft and the operation is limited to a relatively small amount of combustion gases of which, moreover, the greater part are reduced to carbon monoxide and hydrogen in the lower part of the shaft by coming in contact with the incandescent carbon at the bottom.

This method was tried out for several months at the municipal electric works near Berlin. The equipment included a Steinmuller inclined water-tube boiler of about 5400 sq. ft. heating area, with preheating and superheating and two traveling grates with a total surface of about 183 sq. ft. Two tests were run on this boiler, each lasting about 30 hr., one being without the tar plant and one with it. The percentage of fuel heat represented in evaporated steam was 76.8 in the former case and 77.5 in the latter. The gain in evaporation was apparently insignificant, but the dry-tar output was 2.25 per cent, representing 4.3 per cent of the heat in the fuel and bringing the total efficiency of the boiler and distilling plant to 81.8 per cent.

A comparatively small amount of distillation gas was drawn off in

this test, but more recently, in the same installation, the tar output was raised to 4.53 per cent; and since that is twice 2.25 per cent, it should represent approximately twice 4.3, or 8.6 per cent of the heat in the fuel, indicating an overall efficiency of perhaps 86 per cent. (*Power*, vol. 55, no. 25, June 20, 1922, p. 970, 2 figs., *d*)

POWER-PLANT ENGINEERING

Condenser Doors

Condenser Doors. Hick, Hargreaves & Co., Ltd., England, have devised a special arrangement for facilitating the opening of condenser doors when they are formed in two parts and carried on a central hinged pin.

The principal characteristics of the scheme are the provision of means whereby the joint between one half of the door and the condenser can be broken independently of the other joint between the other half of the door and the end of the condenser. In Fig. 7 the two parts of the complete door are shown at *A* and *B* and

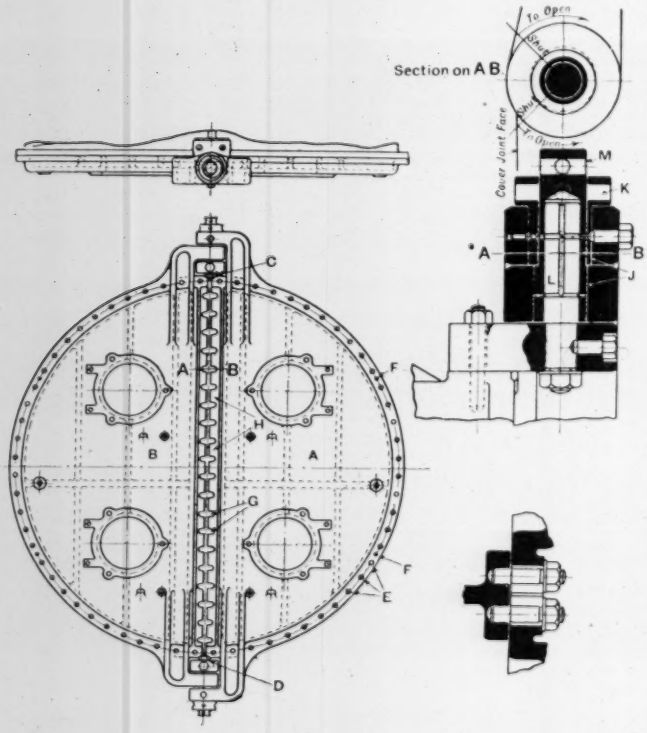

Fig. 7 Arrangement of Doors for a Continuous-Service Condenser

each part is carried on a hinge *C* and *D*. To open either part of the door the joint bolts *E* and the nuts on the studs at *G* are removed and forcing screws *F* are then employed in the ordinary way for breaking the joints. Difficulty however, is liable to be met with in opening the doors *A* and *B* on account of their being close to the central bar on the end of the condenser, any jointing material at the joint *H* being scraped off, while the door is being swung open and again when it is closed.

To overcome this difficulty, however, each of the hinged doors is provided with an eccentric bush *J*, which enables each door to be forced away from the facing on the end boxes. This is done in one case by inserting a tommy bar in the holes *K* of the bush *J*, and in this manner the bush is rotated eccentrically with respect to the main pin *L* and the door is moved away in the desired manner, thus giving the requisite clearance between the door and the facing and enabling the door to be swung round clear of the box facing. When closing the door the operations are repeated in the reverse order. In this way the jointing material along the joint *H* is left intact and the pressure is applied by the eccentric bushes prior to the nuts *G* being put on the studs. When it is desired to open the other door, a tommy bar is placed in the holes *M*. The door can then be swung open independently of the adjacent one. Doors of this type are usually employed in connection with surface condensers using dirty circulating water, as one half of the condenser can be cleaned without entirely shutting down the machine.

Continuous surface condensers are also made by Brown-Boveri. The cooling water flows through the condenser in two streams, the water chambers being divided by a vertical wall and the inlet and discharge branches are duplicated, but the steam space is not divided. When both sides are working the condenser differs from the ordinary type only in the manner in which the water flows through it and also in that the air is ejected from both sides. In order to clean half of the condenser it is merely necessary to close the inlet and discharge valves on the portion it is desired to put out of action and drain off the water which remains in that section. The reduction of vacuum which occurs in consequence of half of the condenser being put out of commission is stated to be only about 3 per cent of full load, while at half-load it is somewhat higher than that attained with both the sections in use under load conditions.

The two-part condenser enables cleaning to be done without putting the turbine out of service. (Abstract of a part of a serial article entitled "Developments in Power Station Design," *The Engineer*, vol. 133, no. 3461, Apr. 28, 1922, pp. 457–459; the abstracted part pp. 458–459, illustrated, *d*)

Pulverized-Coal Burning in a Large Station

Largest Station Using Pulverized Coal. Description of the Lakeside Station at Milwaukee, laid out for an output of 200,000 kw., of which 40,000 kw. is installed.

One of the most interesting features is that the plant is designed to use pulverized coal exclusively, this decision having been arrived at on the basis of experiments in the use of this fuel which the company had been conducting at its Oneida Street power plant for over two years.

Pulverized fuel is fed to the furnace by screw feeders from overhead storage bins. Six out of the eight furnaces are fed from the top with the coal discharging vertically downward, while for experimental purposes the other two were fitted with horizontal burners. Recently, however, horizontal burners were discarded and in all furnaces the vertical method of feeding fuel was employed. The furnace volume is approximately 7000 cu. ft. In certain tests in which capacities ranged from 137 to 236 per cent of rating, the fuel burned per cubic foot of combustion space varied from 0.85 to 1.62 lb.

In the coal-preparation plant the belt conveyor leading to the pulverizing-plant building discharges on a reversible cross-belt conveyor of the same width which distributes the crushed coal to three parallel conveyors equipped with automatic trippers; these latter conveyors pass over the green-coal storage bins in the pulverizing building and maintain an even supply in them. Under the bins run three 12-in. screw conveyors arranged to discharge through automatic scales into three indirect-fired rotary driers 5 ft. 6 in. in diameter and 40 ft. long.

These driers reduce the moisture in the coal by means of hot gases from individual furnaces fired with pulverized coal. Each drier is capable of reducing the moisture content in 10 tons of coal an hour from 10 to 12 per cent.

After being exhausted from the drier, the gas is blown through collectors 14 ft. in diameter which recover any coal dust it carries away in passing through the agitated coal. The hot dry coal is next transported to the mill feed bins by means of parallel arrangements of 16-in. screw conveyors and continuous bucket elevators, each set having a capacity of 60 tons an hour. The idea is to provide spare capacity in case of breakdown. The mills are of the pulverized type, utilizing the air-separation system, and driven by 100-hr. motors their total hourly capacity is 48 tons. They pulverize to a fineness that 75 per cent will pass through a 200-mesh screen and 90 per cent through a 100-mesh screen. With the air-separation method no screens are needed. An exciter driven by the mill shaft draws a current of air over the bull ring in the mill and the velocity of this air is such that it picks up only those particles that have been ground to the necessary fineness.

As the quantity of ash from pulverized-fuel furnaces is small and the ashes fine, it is easily conveyed by steam-jet ash conveyors.

From tests made by the U. S. Bureau of Mines at the plant it would appear that efficiencies of blower and superheater were obtained ranging from 79.8 to 85.2 per cent and efficiencies of boiler, superheater and economizer ranging as high as 89.6 per cent with a minimum of 85.0 per cent. These high efficiencies are credited to the fact that with powdered coal the proper ratio of air to coal can be maintained easily, so that there is small loss due to excess air and practically no loss from incomplete combustion and combustible in refuse. (*Power*, vol. 55, no. 16, Apr. 18, 1922, pp. 604–610, illustrated, *d*)

PUMPS

A NEW FORM OF HIGH-VACUUM AUTOMATIC MERCURY PUMP, H. P. Waran. The pump is based on a modified Sprengel action. It works automatically, the mercury being removed from the lower to the upper reservoir mixed with a current of dry air which is sucked through a side tube by a filter pump. The defects of design of former types of pump are discussed, their inefficiency at low pressures explained, and suitable simple remedies suggested. The introduction of an intermediate reservoir in the middle of the fall tube, kept automatically exhausted by the Sprengel action in the lower fall, allows the upper half to exert a positive exhaustion for every pellet of mercury falling down, even at the lowest obtainable pressure. The absence of compression in the first fall enables the maximum bore to be used for the fall tube; and hence speeds and efficiencies of exhaustion comparable to those of a Gaede pump are obtainable, though less than a pound of mercury is required to operate the pump. (*The Physical Society of London*, vol. 34, pt. III, Apr. 15, 1922, pp. 120–125, 2 figs., *d*)

RAILROAD ENGINEERING

NICKEL-CHROME STEEL RAILWAY COUPLINGS. Description of couplings made by a British concern and tested at the Sheffield testing works. The test was a destruction test, the specified minimum load being 100 tons. In addition to being able to withstand this degree of tension, the nickel-chrome coupling, apart from actual fracture, will carry about twice the tonnage of straight carbon-steel couplings without permanent distortion, the elastic limit being 85 per cent of the ultimate strength. The weight is 10 lb. less than that of the carbon-steel castings.

The production of these couplings became possible because of the wide experienced gathered during the war as to the best heat treatment to insure uniformity and soundness. (*The Engineer*, vol. 133, no. 3464, May 19, 1922, p. 562, 1 fig., *cd*)

RAMSAY CONDENSING-TURBINE LOCOMOTIVE. A brief reference to this locomotive was made in MECHANICAL ENGINEERING (June, 1922, p. 390). It uses the main turbine of the impulse pressure compounded multi-stage type connected through a flexible coupling to a three-phase generator capable of sustaining a 25 per cent overload for half an hour. This generator is separately excited by an auxiliary turbine-driven direct-current generator. The generator supplies power to four three-phase slip-ring motors arranged in two groups on the front and rear parts of the locomotive, respectively. The power is transmitted from a crankshaft to which each pair of motors is geared to six driving wheels on both the forward and rear units of the locomotive, this being done by coupling rods in the ordinary manner.

The rear unit which replaces the usual tender contains the coal bunker and cooling-water tank, as well as the condenser and its accessories. The condenser is of the evaporating type, supplied with air by a fan at the rear of the engine. This fan is illustrated in the original article. The principal dimensions and characteristics are also given in the original article. (*Railway Review*, vol. 70, no. 19, May 13, 1922, pp. 667–668, 2 figs., *d*)

EFFECT OF TONNAGE RATING AND SPEED ON FUEL CONSUMPTION, J. E. Davenport. The author claims that relatively heavy slow-speed trains are the most economical. Taking a modern Mikado-type locomotive, he plots a coal vs. horsepower curve illustrating the increase in efficiency in locomotive performance as the horsepower output increases to a point near 1400 hp., and the decrease as it increases beyond that figure. On the same sheet he plots resistance vs. speed curves, illustrating the decrease in hauling efficiency as expressed in car resistance in pounds per ton as the speed increases and the car weights decrease.

From data obtained in tests by the Pennsylvania Railroad and at the University of Illinois he finds that at the point of maximum horsepower output the coal consumption increases most rapidly with each unit of power produced.

Data of other tests on the Pennsylvania Railroad are used to establish the importance of the empty-car movement in fuel-economy programs and the importance of proper loading of trains. His general conclusion is that the handling of heavier cars and heavier trains and elimination of excessive speeds will greatly assist in reducing the fuel bills. (Paper before the 14th annual convention of the International Railway Fuel Association, abstracted through *Railway Review*, vol. 70, no. 22, June 3, 1922, pp. 777–782, 10 figs., *p*)

LJUNGSTROM TURBINE LOCOMOTIVE. Description of a condensing-turbine locomotive recently placed in service on the Swedish State Railways. According to reports the locomotive has performed in a satisfactory manner and has shown great economy in fuel. Complete details of the construction are not yet available, but from photographs it would appear to be a radical departure from conventional locomotive design.

It is intended to displace the Pacific-type locomotives now in use in passenger service on the Swedish State Railways. Unlike ordinary locomotives, there is no driving machinery under the boiler. Instead it is supported by two trucks, the forward with two and the rear with three axles. The driving machinery is located under the tender unit, which also contains the condenser and the necessary fans for aiding in condensation.

The driving machinery consists of a high-speed turbine geared to the six-wheel-connected running gear which has drivers 58 in. in diameter and is located under the tender. The following arrangement is used for heating the air supplied to the furnace: The space between the mud ring and the ashpan is tightly closed and the air for combustion passes through a special air preheater under the smokebox where the temperature is raised by escaping gases from the smokebox. Draft is created by a fan propelled by a small turbine. A damper connected with the firebox door shuts off the draft when the door opens, thus preventing unnecessary cold air entering the firebox flues. (*Railway Age*, vol. 72, no. 22, June 3, 1922, pp. 1295–1296, 1 fig., *d*)

REFRIGERATION

Tests on Compound Ammonia Compression Refrigerating Systems

COMPOUND AMMONIA COMPRESSION, George A. Horne. An extensive article reporting tests on compound compression systems in two refrigerating plants. Because of lack of space only the major conclusions of this very interesting paper can be reported here.

The machines on which the tests were made are operated with two-stage intercooling in which a gas from the low-pressure cylinder passes through a tubular cooler cooled with well water, and from there into an intermediate receiver into which the high-pressure liquid from the condensers is discharged. The gas is thereby cooled to a temperature corresponding to the intermediate pressure and passes to the high-pressure cylinder; or the high-pressure liquid passes through the intermediate trap where it is cooled to a temperature corresponding to this pressure, and from there passes to the brine coolers. There are no water jackets used on any of the compressors; the liquefied ammonia passes from the ammonia receivers through double-pipe liquid coolers in which it is cooled by well water.

A complete heat balance of the refrigerating cycle is given in the original article.

The results of the extensive tests indicate the advantage of compound ammonia compression with a ratio of compression of six to one or above.

The intercooling by water is clearly demonstrated to be fundamental to the operation of compound compression systems. Where it is impossible to obtain water of a temperature of 60 deg. fahr. a

saving at this stage of the cycle would not be as great, but whatever water is available for condensing purposes there would be a substantial saving in the intercooler.

Among the things found in this test it was fairly established that the venturi meter for measuring liquid ammonia is a valuable instrument in computing capacity of refrigerating machines and may be used to advantage in the practical operation and control of refrigerating system.

Additional tests were carried on in which no liquid intercooling or injection was used, all liquid from the liquid coolers passing directly to the drying, cooling and intercooling between the two stages being accomplished with well water at 60 deg. fahr.

It was found that the operation without liquid intercooling or injection is substantially identical with the operation with liquid intercooling as far as compressor horsepower is concerned. As the chief argument for compound compression over simple compressing hinges on the matter of economy, it is important to determine the simplest and best method of constructing and operating compound compression systems. The author is convinced that any theoretical gain due to liquid intercooling, pressure reduction or injection is offset by losses resulting from handling from 10 to 15 per cent of the total ammonia circulated in the high-pressure side. The elimination of liquid intercoolers materially simplifies the layout of a compound compression system and decreases the first cost. He believes that even 80-deg. fahr. water through the intercooler with a 10-deg. range would hardly justify the installation of the intermediate liquid receivers. He comes to the conclusion that intermediate cooling and injection instead of being essential to compound compression is either entirely unnecesary or merely a refinement of slight merit, while water intercooling is indispensable.

Further tests were carried out by the author and are described in his paper printed in the May issue of the *A.S.R.E. Journal.*

In view of the practice sometimes employed of cooling the low-pressure discharge gas partially or entirely with liquid ammonia, the author has made several observations and comparisons in actual practice in which gas from the intermediate cooler cooled by water was delivered to the high-pressure cylinder with practically no additional cooling by ammonia, and also where additional cooling with ammonia was used he was unable to find any reduction in horsepower per ton in the tests made with this secondary cooling by ammonia. This is of importance, as the use of ammonia in gas cooling results in a reduction of tonnage. Actual calculations have shown that the saving in power due to cooling gas with ammonia is less than 2 per cent, while the reduction in available tonnage is over 5 per cent.

The tests have revealed the fact that in every instance more work was done in the low-pressure cylinder than in the high-pressure cylinder. In some tests over 40 per cent more work was done in the low-pressure cylinders. The author therefore believes (though he does not claim that it had been conclusively demonstrated) that equal work in the two cylinders of a two-stage ammonia compressor produces the lowest horsepower per ton of refrigeration.

He has deduced an empirical formula for determining the correct ratio of cylinder-displacement volumes for two-stage compressors. Without intermediate liquid cooling this is—

$$V = 0.9\sqrt{R}$$

where V = ratio of low- to high-pressure displacement volumes and R = ratio of absolute low suction to high discharge pressures. With intermediate liquid cooling,

$$V = \left[0.9\sqrt{R} - (0.005\,t - t_1)\right]$$

where t = temperature of liquid to intermediate receiver and t_1 = temperature of liquid from intermediate receiver.

For example, let $R = 9$, $t = 70$ deg., and $t_1 = 40$ deg. Solving, $V = 2.55$, which is the correct ratio of low- to high-pressure displacement volumes.

In applying this formula to a common summer ice-making condition, say, of 20 lb. per sq. in. gage suction and 185 lb. per sq. in. gage discharge pressure or ratio of absolute pressures of six to one, with 30 deg. cooling of the liquid, $V = 2.3$. The point might be made that a given cylinder ratio is correct only for one set of conditions, but the answer to that question is found in having a suitable arrangement of clearance pockets on the cylinders. This arrangement of clearance pockets should be such that the highest pressure ratio expected would be satisfied when all pockets are closed on the low-pressure cylinder during the season of heaviest load, which is usually when the condenser pressure is highest. It has been found that the pockets can readily be used to regulate cylinder ratios and at the same time allow reduction in capacity at the time such reduction is desired. The author suggests, for example, that if the maximum ratio of pressures expected requires a cylinder ratio of 2.6 to 1, that an arrangement of pockets should be provided to allow a reduction in cylinder ratios of about 1.8 to 1. (*A.S.R.E. Journal*, vol. 8, nos. 4 and 6, Jan. and May, 1922, pp. 245–296 and discussion pp. 296–307, and pp. 455–487, illus. *epA*)

Influence of Water-Jacket Cooling on Performance of Ammonia Compressors

INFLUENCE OF COOLING WATER JACKET ON THE PERFORMANCE OF COMPRESSION REFRIGERATING MACHINES, Dr. Eng. Walther Fischer. The purpose of this extensive investigation was to determine the influence of the cooling water jacket on the performance of the compressor used in refrigerating machinery. The compressor was operated either in the superheated or the wet state at four different vaporization and three different liquefaction temperatures and an approximately uniform speed of rotation. Fifty-four tests in six series were carried out and analyzed in a manner to bring out the influence of the compressor cooling jacket on the output of cold and power consumption, all of these tests being so arranged that the desired temperature relations and permanent state of operation could be maintained quite uniformly. It was found that in work with superheated steam, operation with cooling water was in every way more satisfactory and that both the output and indicated efficiency increased with the fall in the temperature of vaporization. The total losses of the cylinder of the machine were divided into the part which visibly appears in the diagram and the volumetric efficiency, and the invisible part which originates in the wall action at suction. It was found that jacket cooling makes the volumetric efficiency worse, but improves to a greater extent the wall coefficient so that the employment of a water jacket may be considered as being thoroughly justified.

For purposes of comparison two additional series of tests were carried out: one with a variable speed of operation of the compressor, and another with a variable vapor content in the suction chamber of the compressor. It was found that with an increase of speed of rotation the output and indicated efficiency within the region investigated rose constantly, while the volumetric efficiency remained practically stationary, so that the improvement of output was obtained exclusively through the increase in the value of the wall coefficient. The tests carried out with variable specific vapor content in the suction chamber showed the remarkable superiority of superheated vapor as compared with saturated vapor for refrigerating machinery, and, in particular, that at about 90 per cent the output increases more rapidly; then again begins to decrease slowly, and even at $x = 1$ does not yet reach its maximum. (*Forschungsarbeiten auf dem Gebiete des Ingenieurswesens*, published by the Verein deutscher Ingenieure, 1921, no. 244, 78 pp. and 25 figs., *e*)

Advantages of Certain Hydrocarbon Refrigerants

SOME PROPERTIES OF HYDROCARBON REFRIGERANTS, H. D. Edwards. The increasing interest in refrigerating mediums, due principally to the development of chemical processes requiring temperatures not obtainable with present standard machines; to the desire to perfect the small automatic machine; and to the desire, during the war, of the Government to have developed a substitute for ammonia for refrigerating purposes, has caused a study of refrigerants little used or known and has hastened their commercial production.

The selection of a refrigerant depends upon many conditions, such as its vapor characteristics, latent heat, critical temperature, chemical action on materials and lubricants, deterioration, hazard in handling, danger to life, etc.

That the hydrocarbon gases are good refrigerants has been known for some time, and their first application is recorded in England in 1911. They have been used in this country for the past few years.

The hydrocarbon gases are non-poisonous and do not corrode any materials. They must be handled in the same manner as all other inflammable refrigerants.

The use of butane permits of higher suction pressures than are possible with ethyl chloride, and with propane can be mixed so as to give a positive suction pressure.

Due to the similar vapor characteristics, ammonia and propane may be used together in the same equipment, and a change from one to the other may be made by charging the desired gas as make-up.

The density of propane is 2.6 times that of ammonia. While it takes 2.6 times as much propane to charge the system, it takes 2.6 times as long for it to leak out. In addition, propane will not deteriorate or break down under any conditions possible in the system. The density of propane is 50 per cent greater than that of air.

Standard fittings and valves used in air service may be used with propane as the refrigerant will not injure them.

Accurative comparative tests seem to be the only means of determining whether ammonia or propane has the larger net refrigerating effect under all operating conditions, for their value pound for pound seems to be practically identical.

Temperatures approximately 20 per cent lower than those obtainable with ammonia are being maintained with propane.

Due to the characteristics and low cost of CO_2, the application of ethane is necessarily limited to low-temperature work. Temperatures of —70 deg. cent. (—94 deg. fahr.) are being maintained with a standard CO_2 outfit using ethane as against a minimum of —50 deg. cent. with CO_2.

On account of the low discharge pressures resulting from the use of ethane, there is no more leakage than with CO_2, although the density of the former is the least.

The author is conducting comparative tests on the refrigerants mentioned, and is instituting an investigation to determine the unknown physical properties necessary to obtain complete data, particularly on the hydrocarbon gases. (*A.S.R.E. Journal*, vol. 8, no. 6, May, 1922, pp. 488–495, 5 figs., *de*)

SPECIAL MACHINERY

VISCO AIR FILTER. Description of a new filter of British manufacture, intended chiefly for cleaning air supplied to turbo-alternators, blowers, compressors and ventilating plants. The filtering medium consists of innumerable short rings of very thin coppered-steel tubing of small diameter coated with a very thin film of "viscinol," a high-class mineral oil of special characteristics. It has a very high flash point and the temperature of the fire test is such as to render it practically non-evaporating and non-inflammable. This is very important as it is essential that there should be no possibility of oil vapors being formed at any temperature likely to occur in practice. At the same time the solidifying temperature is exceptionally low, so that the filter is not affected by frost. The oil is very viscous, which prevents it from running. The cells which contain the filtering ring are made in standard sections about 20 in. sq. and 3 in. deep and are stamped out of steel in one operation. The filtering rings lie quite irregularly in the cell and offer a very large surface to the air passing through, 1 cu. ft. of rings representing about 300 sq. ft. Due to their irregular position the air is deflected from its straight course a great number of times without at the same time meeting with any undue resistance, which varies from 4 mm. to 8 mm. (0.16 to 0.32 in.) of water according to the time the filter has been in use. After several months of operation the filter is cleaned by either hot soda water or steam, subsequent to which the cells are recoated with viscinol by simple immersion. (*The Electrical Review*, vol. 90, no. 2321, May 19, 1922, p. 717, 3 figs., *d*)

SPECIAL MACHINERY

WIRE SAWS FOR SLATE AND MARBLE CUTTING. Description of products of British manufacture. The cutting wire (helicoidal) in the plans described is continuous and is passed from place to place by means of guide pulleys. The wire travels at about 12 miles per hour. It is made in lengths of from 220 to 880 yd., sometimes more, and in three diameters, 4 mm., 5 mm. and 6 mm., the lighter-gage wire being employed for yard sawing and the heavier for quarry work. In a large working the cutting wire is sometimes driven by a pulley fixed on a countershaft which may drive one or more lines of cutting wire each with its own friction clutch so that each can be worked independently of the other. The wire saw is a useful and economical machine, being cheap to operate, requiring little horsepower, and only occasional attention to see that sand and water are kept fed into the cut. They have been developed primarily for marble working, but can be easily adapted to slate cutting. Attempts to use them for sandstone cutting did not apparently turn out well, because of the excessive wear on the wire. The original article describes the details of their installation. (*The Quarry and Surveyors' and Contractors' Journal*, vol. 27, no. 303, May, 1922, pp. 181–183, 4 figs., *d*)

STEAM ENGINEERING (See Thermodynamics)

Nozzle Losses in Compound Steam Turbines

NOZZLE LOSSES IN COMPOUND TURBINES. Certain continental engineers have claimed that the higher the steam speed, the more efficient the turbine. This theory is based on the fact that, taking any given nozzle, the higher the velocity of efflux, the less proportionately is the energy wasted in friction. This view is supported also by practical experience.

In a paper published in 1919 in the *Zeitschrift des Vereines deutscher Ingenieure*, Dr. R. Fluegel suggested that the explanation might be found in the fact that a dimensional factor is involved in the resistance to flow of fluids through similar channels.

If in a steam turbine the steam speed be diminished larger nozzles will be required to pass a given quantity of steam, and Fluegel suggested that in this increase of dimension was to be found the explanation of the fact that in practice turbines with low steam speeds appear to be quite as efficient as turbines with high steam speeds.

By the principle of dynamic similarity established by Stokes in 1850, the resistance R per square centimeter of rubbing surface is given by the relation

$$R = \rho v^2 \phi \left[\frac{v}{vd}\right]$$

where ϕ denotes some function of the expression in brackets, ρ the density of the fluid in grams per cubic centimeter, v the velocity of flow in centimeters per second, υ the kinematic viscosity of the fluid, and d the diameter of some other typical parameter of the waterway.

From experiments analyzed by Prof. C. H. Lees (*Proc. Roy. Soc.*, 1914) it would appear that at low velocities the plotted points fall on an entirely different curve to that which represents them at higher velocities of flow. In the former case the flow is linear in character, while at higher velocities it is turbulent and there is a region of transition between the two curves in which observations plot erratically and repeat experiments do not necessarily yield concordant results. This confirms the truth of the law of dynamic similarity, which may be therefore applied to Dr. Fluegel's program.

For smooth nozzles the author derives the formula for the energy dissipated per unit mass passed per second, as follows:

$$\frac{C}{2} \times v^2 \times \left[\frac{\mu d}{m}\right]^n \qquad (7)$$

where C is a constant, m the mass passed per second, μ the viscosity of the fluid, n a small fractional power of the order of 0.1 to 0.2, and d the diameter of the nozzle. In the case of the nozzle, v denotes the actual velocity attained. He shows further that the percentage loss in a nozzle is proportional to $(\mu d/m)^n$.

In a turbine in which the steam speed is high the value of d will be less than in a turbine passing the same mass of steam per second but having a greater number of stages. Hence if n be, as it is natural to suppose, a positive number, the nozzle losses will be less in the high-speed turbine, and the fact that this is not supported by experience must be sought elsewhere than in the dimensional factor suggested by Dr. Fluegel.

Actual experience may be explained in part by the fact that the more stages in the turbine, the higher the reheat factor; but cal-

culation shows that the gain due to this circumstance is very small. The slow-speed turbine has, however, another advantage in that the losses by disk friction and the like in a slow-speed turbine of given output are smaller proportionately than in a machine with high blade speeds. In the foregoing the value of n has been left indeterminate. In the case of parallel pipes it is known to be a small fraction, but its value for nozzles does not seem to have been investigated. Such a research would be of interest and could be carried out with comparatively simple apparatus, using water as the fluid. The viscosity of water is about four times as great at 0 deg. cent. (32 deg. fahr.) as it is at 50 deg. cent. (122 deg. fahr.), so that a fair range of values would be readily available, and from the principle of dynamic similarity the coefficients found for water would also apply to steam.

From this the author proceeds to show that, in accordance with the theory of dynamic similarity, when any viscous fluid flows through a channel the frictional resistance per square centimeter of wetted surface must be expressible in the form

$$\rho v^2 \phi \left(\frac{v}{vd} \right)$$

(*Engineering*, vol. 113, no. 2942, May 19, 1922, pp. 607–608, 1 fig., *t*)

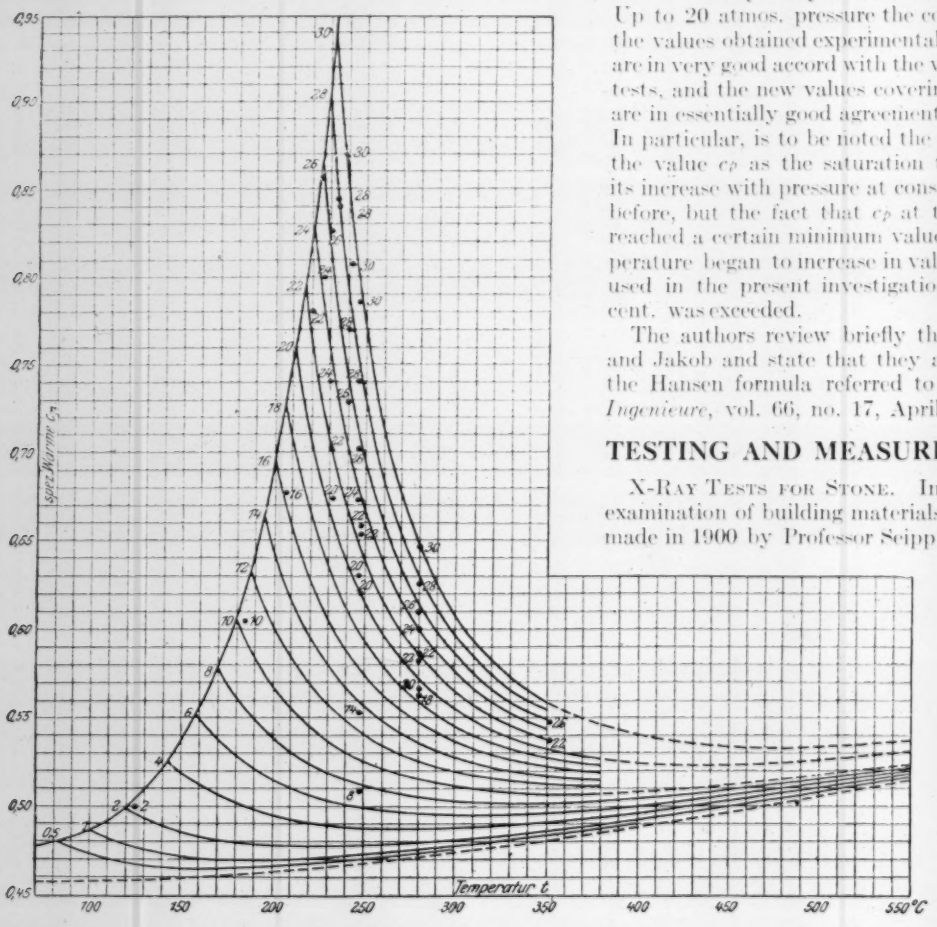

FIG. 8 SPECIFIC HEAT (c_p) ISOBARS IN THE c_p-t DIAGRAM
(Ordinates; *spez. Waerme* = specific heats.)

THERMODYNAMICS

SPECIFIC HEAT OF SUPERHEATED STEAM FOR PRESSURES FROM 20 TO 30 ATMOS. AND FOR SATURATION TEMPERATURES UP TO 350 DEG. CENT., Oscar Knoblauch and Erwin Raisch. Description of tests carried out in the Laboratory for Technical Physics at the Munich Technical High School, where so many important previous investigations on the thermodynamic properties of steam have been carried out, among others by the first of the authors of this paper. The present investigation extends the range of previous research to the higher pressures and temperatures indicated in the title.

The results obtained in this investigation are in good conformance with those previously obtained for the lower ranges and further confirm previous observations to the effect that the specific heat increases with the pressure, but decreases with the increase of temperature beginning with the temperature of saturation. In the original article the results are given in a number of tables in addition to which one figure gives the c_p isobars in the c_p-t diagram. (Fig. 8).

In these figures the abscissas are temperatures and the ordinates are c_p values obtained experimentally and by interpolation reduced to whole numbers. Through the points thus obtained curves have been drawn connecting points of equal pressure. For the sake of completeness isobars for pressures below 20 atmos. were plotted as obtained from previous investigations. The part of the curve drawn in full line covers the region determined experimentally; the broken-line curves have been obtained by means of extrapolation.

The curves are based on an equation by A. Hausen (apparently unpublished) which expresses c_p as a function of temperature and pressure. Its constants have been determined from observed values by the method of least squares. From Fig. 8 it would appear that the deviation of the points experimentally obtained from the analytically determined curves is in general less than one per cent. Up to 20 atmos. pressure the comparison between the isobars of Fig. 8 and the values obtained experimentally and given in a table in the original article, are in very good accord with the values previously obtained in the the Munich tests, and the new values covering the region from 20 to 30 atmos. pressure are in essentially good agreement as to general behavior with the old values. In particular, is to be noted the marked increase at the higher pressures in the value c_p as the saturation temperature is being approached, as well as its increase with pressure at constant temperature. This has been observed before, but the fact that c_p at the lower pressures and rising temperature reached a certain minimum value, and then with a further increase of temperature began to increase in value, was observed at the higher temperatures used in the present investigation only when the present limit of 350 deg. cent. was exceeded.

The authors review briefly the latest work of Hencky, Plank, Eichelberg and Jakob and state that they are at present engaged in further work on the Hansen formula referred to above. (*Zeitschrift des Vereines deutscher Ingenieure*, vol. 66, no. 17, April 29, 1922, pp. 418–423, 9 figs., *et.A*)

TESTING AND MEASUREMENTS

X-RAY TESTS FOR STONE. In Germany attention is being given to the examination of building materials by means of X-rays. Investigations were made in 1900 by Professor Seipp; and more recently Prof. L. Freind and the late Prof. A. Hanisch have made some extensive researches on the action of X-rays on slates, both natural and artificial. Twelve kinds of clay slate were examined, and various structures were observed in the X-ray diagrams, giving clear indications as to the uniformity and arrangement of the slaty substance. The most conspicuous advantages of the X-ray method as compared with other testing processes are its cheapness and rapidity, as well as the ease with which it can be used without any elaborate or difficult preparation, independently of any chemical analysis or the use of transparent microscopic sections, on large samples as well as on small amounts of material. Other kinds of building material, listed in the complete article, showed interesting variations in permeability to X-rays. (Editorial article in *Quarry and Surveyors' and Contractors' Journal*, vol. 27, no. 303, May, 1922, p. 167, *g*)

CLASSIFICATION OF ARTICLES

Articles appearing in the Survey are classified as *c* comparative; *d* descriptive; *e* experimental; *g* general; *h* historical; *m* mathematical; *p* practical; *s* statistical; *t* theoretical. Articles of especial merit are rated *A* by the reviewer. Opinions expressed are those of the reviewer, not of the Society.

ENGINEERING RESEARCH

A Department Conducted by the Research Committee of the A.S.M.E.

Research Résumé of the Month

A—Research Results

The purpose of this section of Engineering Research is to give the origin of research information which has been completed, to give a résumé of research results with formulas or curves where such may be readily given, and to report results of non-extensive researches which in the opinion of the investigators do not warrant a paper.

Corrosion A1-22. Deterioration of Structures in Sea Water. Since 1916 a series of investigations into the deterioration of structures of timber, metal and concrete in sea water has been undertaken by a committee of the Institution of Civil Engineers, London, with the aid of a grant from the Department of Scientific and Industrial Research. The first report of the committee was published in 1920, and it is now considered advisable to issue the present interim report which deals with work subsequently undertaken.

The report is arranged under the following headings:

Report on deterioration of structures exposed to sea action. (Admiralty.)

Report on the action of worms in the water of the Mediterranean round Malta.

Memorandum dealing with condition of materials of construction of docks, etc., exposed to the action of sea water. (Portsmouth.)

Report on deterioration of structures exposed to sea action. (Devonport.)

Report on the preparation of the various steel and iron specimens for the Committee on Sea Action of the Institution of Civil Engineers. (Sir R. Hadfield).

Report on the work done for the Committee on Sea Action, 1920–21. (J. N. Friend.)

Report on the investigation of the protection of timber against teredo attacks. (G. Barger.)

Report of work done at the Marine Biological Station, Plymouth, July 1 to September 18, 1920. (C. R. Harington.)

Abstracts from Bulletin of the Public Works of the Navy. (United States.)

Abstracts of reports received from correspondence.

Address H. M. Stationery Office, Imperial House, Kingsway, London, W. C. 2. Price 2s. 8d.

Electrical Communication A1-22. Radiation from Special Form of Antenna. The Bureau of Standards has just published a paper giving the theory of the radiation from an antenna consisting of 2 horizontal coils. The area within which the signal is heard, and the point at which it is most intense, are discussed. The results of these investigations are given in Bureau of Standards Scientific Paper No. 431, The Field Radiated from Two Horizontal Coils, which may be obtained from the Superintendent of Documents, Government Printing Office, Washington, D. C., at 5 cents a copy.

Fire Prevention A2-22. Fire Tests of Loaded Timber Columns. See *Framed Structures A1-22.*

Framed Structures A1-22. Fire Tests of Loaded Timber Columns. In an address delivered at the "Building Officials Conference" Mr. T. F. Laist of Chicago gave the results of a series of tests recently carried on by the National Board of Fire Underwriters. The fire-endurance classification of a nominal 12-in. by 12-in. select structural longleaf Southern pine or Douglas fir column of ordinary length, may be more than doubled if the ends are adequately protected against fire. It appeared from these tests that instead of a thirty-five minute endurance rating, a one and one-quarter hour rating may safely be given provided the steel caps as ordinarily used are insulated or a concrete cap is used, thus preventing the crushing and brooming of the wood fibers under the cap and causing failure long before the sectional area of the column is otherwise reduced to the point of failure. It was also shown that such adequate fire protection for the ends of timber columns in mill construction buildings may be obtained by reinforced-concrete post caps such as were used in these laboratory tests. While such caps have been successfully devised for experimental purposes, so far they have not been commercially produced, nor have such tests been made upon caps supporting girder loads.

While in this series of tests no experimental work was done with steel or cast-iron caps, it is apparent that consideration of the results obtained would suggest that adequate insulation for the ends of timber columns may be obtained from the installation of fireproof materials on the exposed faces of standard steel or cast-iron post caps. The tests also verified the greater superiority in fire resistance of timber construction to unprotected steel or cast-iron framing. Address Theo. F. Laist, 1613 Harris Trust Building, Chicago, Ill.

Fuels, Gas, Tar and Coke A10-22. Smokeless Fuel for Salt Lake City. In a brief but satisfactory way Messrs. G. St. J. Perrott and H. W. Clark have prepared a report on their investigations on this subject. This report is known as Bureau of Mines Serial No. 2341. It is a consideration of the practicability of by-product coking of Utah coals for supplying smokeless fuel to domestic consumers of Salt Lake City. The paper reviews briefly the work of the senior author and others in connection with the experimental side of low-temperature coking of Utah coals. The economic feasibility of supplying the entire domestic demand of Salt Lake City with carbonized smokeless fuel is considered from several viewpoints. The discussion includes a consideration of high-temperature and low-temperature carbonization in connection with the character of the coke and by-products produced and their suitability for disposal on the Salt Lake City market.

Two of the four conclusions reached by the authors are interesting. (1) While the coke and by-products of a low-temperature carbonization plant would probably find a readier market than those of a standard high-temperature plant, neither plant would be a commercial success without protective legislation. A semi-experimental 100-ton plant should be able to operate with a smaller differential between the price of coal and coke due to more favorable disposal of the smaller volume of by-products. (2) No single solution for the domestic smoke nuisance appears available. Means which should be considered for alleviating the nuisance are (1) sale of the available supply of gas-house coke; (2) briquetting of coke breeze from the beehive ovens at Sunnyside for domestic fuel; (3) burning of powdered coal where feasible; (4) installation of semi-experimental 100-ton plant for low-temperature carbonization; and (5) continuation of educational campaign to teach domestic consumers proper methods of firing the native coal. Address Reports of Investigations, U. S. Bureau of Mines, Department of Interior, Washington, D. C.

Fuels, Gas, Tar and Coke A11-22. Preparation and Uses of Tar and its Derivatives. The importance of tar as a commercial product has been emphasized during the past five or six years more than ever before. In that time, the market for tar and its products fluctuated in an unprecedented way, because of the war and other conditions, with the result that the production of tar and tar products increased greatly. A large proportion of the increase is due to the installation of by-product coke ovens, which are fast replacing the beehive ovens, from which tar and other by-products are not recovered.

This paper discusses the uses to which some of the various tars are put and shows briefly the usual methods of working up tar into some of its simple or easily prepared derivatives, for which a market can generally be found. Although coal tars are given chief consideration, the properties and characteristics of water-gas tar are mentioned, for the reason that this tar is often produced in plants where coal tar is made, the mixed tar being collected and marketed, and for the further reason that the presence of water-gas tar in some coal-tar products is specifically interdicted by commercial specifications. This publication is not a handbook on tar distillation, for that subject can hardly be covered adequately in such limited space, but is published by the Bureau of Mines as a general treatise on the utilization of tar. Address Superintendent of Documents, Government Printing Office, Washington, D. C., asking for Bureau of Mines Technical Paper 268. Price 15 cents.

Metallurgy and Metallography A2-22. Metallographic Etching Reagents. II—For Copper Alloys, Nickel, and the Alpha Alloys of Nickel. This article constitutes the second part of the general investigation of metallographic etching reagents in progress at this Bureau. It is closely related to the one already published on copper in the methods employed and results obtained. The following materials were used: Copper alloys, including brasses, bronze and aluminum bronze; nickel and the alpha alloys of nickel, monel metal, cupronickel and nickel brass.

Experimental results are given to show the importance of films in producing contrast in etching. Oxide and sulphide films were used, and it was shown by separating the etching and the filming operations that films varying in thickness on the individual crystals are produced by certain reagents and give rise to "contrast." The better-understood methods for producing contrast by a differential roughening of the crystals upon etching is also illustrated.

The alpha copper alloys closely resemble copper in their general behavior upon etching and in the character of the results produced. The addition of tin to brass appears to render it slightly less responsive to etching reagents than the same alloy without tin; aluminum bronze in the rolled condition was the most unsatisfactory of the copper alloys examined to etch. A series of copper-zinc alloys representative of all the types of structure in this series was examined. The alloys rich in zinc resemble this metal in their etching characteristics more than they do the copper-rich alloys, in that highly oxidizing etching reagents do not appear to be necessary for the successful etching of the alloy.

Nickel, particularly when of high purity, is etched with considerable difficulty. Oxidizing acids, such as nitric, and acids to which strong oxidizers had been added were found effective for a quick etching.

For producing a contrast etch-pattern with freedom from pitting, a long immersion in concentrated hydrochloric acid was found to give excellent results.

Of the alpha-nickel alloys examined, monel metal and cupro-nickel were found to resemble nickel in their etching properties, though they etched more readily. The nickel brasses (nickel silver) resemble the alpha-copper alloys in many respects and were readily etched by the reagents used for the brasses and bronzes.

This report was prepared by H. S. Rawdon and Marjorie G. Lorentz of the Bureau of Standards and is known as Scientific Paper No. 435. For copies address Superintendent of Documents, Government Printing Office, Washington, D. C. Price 15 cents.

Petroleum and Allied Substances A5-22. EVAPORATION OF PETROLEUM. Bulletin 200 by J. H. Wiggins of the Bureau of Mines. In 1919 the United States was threatened with a shortage of gasoline. In spite of this well-known fact, a detailed field investigation has shown that in one stage only of handling crude oil the volume of gasoline that evaporates is equal to one-thirtieth of the country's yearly gasoline production. This loss occurs during the few days that the oil is stored on the leases before being taken by the pipe line, and in 1919, in the Mid-Continent field alone, it amounted to 122,100,000 gallons. Large as it is, it is only a part of the loss on the lease. Investigation has further shown that the gasoline in crude oil evaporates from one-half to six-tenths as rapidly as the same gasoline after being distilled and stored, all evaporative conditions being the same.

In accordance with its purpose of seeking to conserve mineral resources, the Bureau of Mines investigated the loss of gasoline by evaporation in the storage and handling of petroleum. Inasmuch as most producers had not decided that their losses justified corrective measures and no evidence was available on the comparative losses in various stages of handling the oil, the investigation was limited to determining by experiment and observation the nature and magnitude of evaporation losses, where the greatest losses are, and the factor controlling evaporation. The results of the investigation, as presented in this report, indicate that losses from evaporation are so large that they should receive serious consideration at once by the industry, which should make every endeavor to reduce them to a minimum. The Bureau of Mines is now making a supplementary study of methods of reducing these loses.

This bulletin has three parts: First, a general discussion of the problem and the methods of attack; second, volumetric losses during various stages of handling and in various kinds of storage; third, scientific data on the evaporation of petroleum. Address Superintendent of Documents, Government Printing Office, Washington, D. C.; price per copy, 20 cents.

Petroleum and Allied Substances A6-22. THE ANALYTICAL DISTILLATION OF PETROLEUM AND ITS PRODUCTS. Fractional distillation is the most important process in the commercial refining of petroleum. The same procedure, conducted on a small scale, is the basis of a number of analytical methods of wide application in the petroleum laboratory. The Bureau of Mines has studied apparatus and procedure for the distillation analysis of petroleum, and this report is presented as a record of developments up to the present time. The work is incomplete, but the extensive information that has been obtained to date is made available as a guide in handling the laboratory-distillation problems. Address Superintendent of Documents, Government Printing Office, Washington, D. C., and ask for Bureau of Mines Bulletin 207. Price 15 cents.

Petroleum and Allied Substances A7-22. METHODS FOR TESTING PETROLEUM PRODUCTS. The methods included in this handbook are used officially in the routine testing and inspection of petroleum products bought under Federal specifications. They supersede similar methods published in Bulletins 1 to 5, inclusive, of the Committee on Standardization of Petroleum Specifications. This set of testing methods, known as Bureau of Mines Technical Paper 298, was prepared by the Technical Committee on Standardization of Petroleum Specifications and was adopted by the Interdepartmental Petroleum Specifications Committee. Address the Superintendent of Documents, Government Printing Office, Washington, D. C. Price 10 cents.

B—RESEARCH IN PROGRESS

The purpose of this section of Engineering Research is to bring together those who are working on the same problem for coöperation or conference, to prevent unnecessary duplication of work and to inform the profession of the investigators who are engaged npon research problems. The addresses of these investigators are given for the purpose of correspondence.

Corrosion B4-22. RESISTANCE OF CHROMIUM STEELS TO ACID CORROSION. Tests of the resistance of chromium steels to acid corrosion have recently been completed, and a comparison of the results obtained shows that the relative resistance of a steel to the acid test is not necessarily a criterion of its behavior in other types of corrosion. Pure iron and the steels of low chromium content were found to be much more resistant to attack by hydrochloric acid than those containing considerable chromium. When corroded by water and air, the general order of resistance was reversed. It may be concluded, then, that the addition of chromium increases the rate of attack by hydrochloric and probably by other acids, although this may depend somewhat on the heat treatment which the steel has received. Specimens which had been hardened by suitable heat treatment were found to be considerably more resistant to acid attack than samples of the same composition in the annealed state. The addition of nickel is much more effective in reducing the intensity of the attack by acid than is chromium, since steels containing a considerable amount of this metal were found to be the most resistant to acid of all those tested. Specimens having a polished surface were found, almost invariably, to show a smaller loss in acid than those which were roughly ground.

This difference may be only apparent however, because although the measured surface of two specimens may be exactly the same, the one with a "ground" finish has a slightly greater area exposed on account of the minute grooves and ridges which make up the surface than has the polished specimen. Address Dr. S. W. Stratton, Director, Bureau of Standards, Department of Commerce, Washington, D. C.

Highways B3-22. RECENT DEVELOPMENTS IN THE WORK OF HIGHWAY RESEARCH. The recent progress in the study of this subject by the Advisory Board on Highway Research is outlined in a four-page pamphlet. Copies of this pamphlet may be secured by addressing the Secretary of the Division of Engineering, National Research Council, 29 West 39th Street, New York.

The subdivisions of the subject discussed are: Design of Stiff Slabs, Materials, Traffic Studies, and Economics. It is also recorded that four new committees of the Advisory Board have been authorized to take up investigations of the following subjects: Highway Finance, Highway Traffic Analysis, Maintenance, and Highway Bridges.

D—RESEARCH EQUIPMENT

The purpose of this section of Engineering Research is to give in concise form notes regarding the equipment of laboratories for mutual information and for the purpose of informing the profession of the equipment in various laboratories.

Hydraulics D1-22. HYDRAULIC LABORATORIES IN THE UNITED STATES. A Directory of Hydraulic Laboratories in the United States has been compiled under the direction of the Hydraulic Research Committee of the Engineering Foundation, the members of which are J. Waldo Smith, Chief Engineer, Board of Water Supply of the City of New York, and Silas H. Woodard, Consulting Engineer, New York. The book has eighty-four 7 by 10-in. pages and contains information concerning 49 laboratories in engineering colleges, industrial establishments and governmental bureaus. Only statements furnished by the person responsible for the laboratory have been used in each case. Indirectly, this information affords comparison of equipment in the various laboratories and suggests possibilities of greater usefulness in some instances. The information will be helpful to those contemplating the establishment of new laboratories, to persons desiring to have hydraulic tests or experiments performed, and to students choosing schools in which to pursue the study of hydraulic engineering.

Persons desiring copies of the Directory of Hydraulic Laboratories, or more information regarding Engineering Foundation, should address Alfred D. Flinn, Secretary, 29 West 39th Street, New York.

F—BIBLIOGRAPHIES

The purpose of this section of Engineering Research is to inform the profession of bibliographies which have been prepared. In general this work is done at the expense of the Society. Extensive bibliographies require the approval of the Research Committee. All bibliographies are loaned for a period of one month only. Additional copies are available, however, for periods of two weeks to members of the A.S.M.E. These bibliographies are on file at the headquarters of the Society.

Sampling, Coal, Ore, Liquids, etc. F1-22. The Bureau of Mines in its usual thorough way has just completed a bibliography of the literature on sampling. This report was prepared by Messrs. W. J. Sharwood and M. Von Bernewitz and is known by Serial No. 2336; 85 mimeograph pages, 8 by 10½ in.

So far as is known, there is no complete bibliography on sampling; this one, therefore, should be of value. In it are nearly eleven hundred references, some dating back 30 years, on sampling at mines, mills, smelters, power plants, pumping stations and refineries. For convenience there are included a few references to methods for sampling such materials as leather belting in mills, salt-impregnated soils, and mine waters. All the important technical journals, including some in foreign countries and engineering society publications, also mining and metallurgical textbooks, have been studied for anything concerning sampling, and while it is not claimed that every important reference has been listed, the bibliography is fairly complete.

The arrangement is alphabetical by authors' names, and the references are numbered serially in the order that they appear in the bibliography. Anonymous references are listed under the name of the journal in which they appear, and are numbered like the references bearing an author's name. Patents are grouped in their numerical order, without index numbers. The report is provided with a subject index. Address H. Foster Bain, Director, Department of the Interior, Bureau of Mines, Washington, D. C.

CORRESPONDENCE

CONTRIBUTIONS to the Correspondence Department of MECHANICAL ENGINEERING are solicited. Contributions particularly welcomed are discussions of papers published in this journal, brief articles of current interest to mechanical engineers, or suggestions from members of The American Society of Mechanical Engineers as to a better conduct of A.S.M.E. affairs.

The Surge-Tank Problem

TO THE EDITOR:

The writer has carefully read an article by Professor Durand appearing in the October, 1921, number of MECHANICAL ENGINEERING, in which he recommends the construction of models in order to solve surge-tank problems experimentally.

Such problems are so easily, quickly and accurately solved by the process of arithmetic integration that the necessity or desirability of a comparatively expensive model is quite incomprehensible to the writer.

Table 1 shows an example of arithmetic integration as applied to Professor Durand's first illustrative problem. For convenience the value of n is taken as 2 and an instantaneous shutdown is assumed. It is only a little more work to plot a reference curve for friction variation with $n = 1.85$, but there is no practical reason for doing so. The successive computations are made for time intervals of 10 sec. Only three columns of figures are necessary for this work and no figures whatever are used other than those set down.

TABLE 1

CHANGING VALUES OF V	CORRESPONDING VALUES OF Y	Δh_f
10.000	7.721	0.00
0.124	7.625	
9.876	15.346	1.30
0.226	7.450	
9.650	22.796	3.60
0.309	7.210	
9.341	30.006	6.40
0.380	6.920	
8.961	36.926	9.85
0.436	6.580	
8.525	43.506	13.70
0.480	6.210	
8.045	49.716	17.70
0.516	5.810	
7.529	55.526	21.70
0.544	5.390	
6.985	60.916	25.60
0.568	4.955	
6.417	65.871	29.42
0.587	4.500	
5.830	70.371	33.03
0.601	4.036	
5.229	74.407	36.36
0.613	3.564	
4.616	77.971	39.35
0.622	3.082	
3.994	81.053	42.03
0.628	2.598	
3.366	83.651	44.33
0.633	2.110	
2.733	85.761	46.27
0.636	1.620	
2.097	87.381	47.80
0.637	1.127	
1.460	88.508	48.94
0.637	0.635	
0.823	89.143	49.66
0.636	0.144	
0.187	89.287	

The time consumed in making this entire computation should not exceed 35 min.

The process should be apparent upon casual inspection, but it may be described as follows: Column 1 denotes velocity in the conduit, column 2 departure of water level upward from its original position, and column 3 the change in the friction loss.

During the first ten seconds the rise in water level of 7.721 is determined by dividing the conduit velocity by the constant 1.295, which is one-tenth of the ratio of the surge-tank area to the conduit area. For non-cylindrical tanks this ratio is simply made variable with respect to Y and read from a previously prepared curve.

In ten seconds' time the velocity in the conduit will change 0.0161 × the retarding head or, say, 0.124 during the first time interval. Subtracting this from the original velocity we have a new velocity of 9.876; dividing this by 1.295 we have 7.625, which added to Y gives the new value of Y as 15.346.

The change in friction from the original velocity to the present one is 1.3 ft., which subtracted from 15.346 gives the new accelerating head; this multiplied again by 0.0161 gives a retardation of 0.226 in the next time interval. This process is continued until the conduit velocity becomes zero, at which time the water has risen 89.287 ft.

The arbitrary unbalancing at the beginning is an inseparable feature of arithmetic integration, and although it is likely to hurt the feelings of pure mathematicians, the error which is initiated is not cumulative but rather is it self-corrective during the subsequent successive computations.

The change in friction can be read directly on a slide rule by squaring the velocity, multiplying by 0.5 and reading backward from 50 ft. on the upper slide. The subtraction of the friction change from the rise in each case need not be carried beyond the second place, and can easily be done mentally and set directly on the slide rule to be multiplied by the constant 0.0161. This example, to be sure, is a simple one, but there is no case too complicated not to be susceptible of the same general treatment.

When demanded loads are considered it is necessary to carry a fourth column denoting draft velocity, and this draft velocity may be made to vary in any conceivable manner, for example, in such a way as to keep the power output constant. Such a study would be in no way more difficult than the one illustrated, but would simply require more time.

It will be noted that in using the foregoing method no trial-and-error work is required. The computations are always straightforward, however complicated the problem. If greater accuracy should be required, the time interval could be cut in two, using 5 sec. instead of 10 and doubling the work, but it is hardly likely that the figure 89.287 differs from the true result by as much as three-quarters of one per cent.

The writer has had exceptional opportunities during the past twenty years to observe actual results as compared with such computations as are here presented, and he feels competent to make the unqualified statement that the construction of models for the purpose of solving surge-tank problems is a waste of time and money and cannot possibly lead to results as accurate as those which are easily computed. In fact, once the variation in friction is assumed known, the behavior of the model itself can be readily ascertained by numerical calculation, even for periodic load changes, and with greater accuracy than that with which it can possibly be observed experimentally.

The writer wishes to take particular exception to Professor Durand's fifth enumerated advantage of the model method, and to state the fact that periodic fluctuations of any sort are so assuredly within practical reach of numerical methods that he has found no difficulty in training inexperienced men to do such work. When the differential principle is used, periodic load changes never cause any serious trouble and therefore need no study.

A practically accurate formula for cases similar to the one here illustrated is as follows:

$$N^2 = \frac{6}{3K^2 - \left(2K + \frac{1}{K^2}\right)}$$

where $N^2 = 2gc^2v_2^2F/AL$ and K is the ratio of the total upward surge to the original friction loss, or $K = Y_1/CV_2^2$.

Where the differential principle is used in designing the surge tanks, it is usually unnecessary to resort to the expedient of arithmetic integration.

The direct use of such formulas as are published in the writer's article (Trans. Am.Soc.C.E., 1915) is quite sufficient to work out

accurately an ordinary design. The use of expensive models for the purpose of such solutions would be even more uncalled for, if possible, than in the case of the simple tank studies; furthermore it is difficult for the writer to find any excuse for omitting the differential principle when its use, without exception, produces a cheaper surge tank which will fulfill the same conditions.

For example, in the present instance a differential surge tank only 25 ft. in diameter would cause the water level to rise about the same amount as this 36-ft. simple tank, and it would behave better for the usual requirements of demanded load.

There are so many short cuts available to those who are familiar with the use of the slide rule to assist in arithmetic integration that it is impossible to point them out except in each special case, but they readily occur to most people as practice instructs them. The writer has never found a case too difficult to solve by simple commonsense processes which are available to the mind of any one familiar with Newton's laws of motion. Casting ahead or trial-and-error methods are almost never required. If great refinement is desired the time of a quarter-cycle should be divided into thirty or more parts, but twenty is usually sufficient for practical purposes, as here illustrated.

The interested student may try shorter time intervals. By plotting the final results of several such computations it is easy to find by extrapolation the practical limit where further subdivision of the time gains nothing in accuracy, and this point might well be found in the present case when thirty subdivisions were reached.

By plotting a reference curve between N and K (not N^2) from the formula given, all cases of non-spilling shutdown can be immediately solved with almost no effort, and the results are entirely trustworthy. The derivation of this equation, however, is too long to be set forth in this discussion.

CORRECTION OF AN ERROR

The writer wishes to take this opportunity to correct an error of which he was guilty in a paper on the surge tank published in the 1908 A.S.M.E. Transactions.

This error was discovered some six or seven years ago, but inasmuch as no one ever called attention to it, he let it go uncorrected with the thought that where there was not shown a sufficient interest even to discover the mistake, it was probably doing no harm.

Recently, however, it has come to his attention that this old paper, although badly out of date, is still made use of by some engineers, and he therefore believes it worth while to point out what is probably its worst fault.

Reference is therefore made to page 850 of the volume in question, where there appears a formula for the critical size of a simple tank as follows:

$$R = \frac{Khq}{L}$$

As a matter of fact, K is not constant except for cases where C accidentally has the same value, or in other words, K varies with C and is equal to $2C$.

In this form it is known as the Thoma formula and the writer has also derived it independently. It will be observed that the critical value of R is independent of L because C varies directly with L.

New York, N. Y. R. D. JOHNSON.

Railway and Tramway Wheel Design

TO THE EDITOR:

Engineering has, of necessity, been largely a matter of development based on trial-and-error methods, and it has therefore happened that certain details of design or construction have become fashionable (the word is used advisedly) and an engineer must be something of a hero to suggest a departure from what are called standardized methods. Thus in railway practice the idea of keeping the rail joints opposite one another outlived its just life by many years, for as with the use of railway metals of large section and with improved fishplates resilience at the joint was almost eliminated; moreover the use of bogies on fast-traveling trains eliminated the jump that used to be so much feared as the wheels passed over the joints.

In a similar manner coning of the wheel treads was resorted to in some sort of belief that a compensating effect was produced when a pair of wheels, rigidly connected to an axle, passed round a curve; there seems to be a further underlying idea that in some way the coning assists in keeping the vehicle centralized on the track.

Even a cursory investigation of the circumstances of modern rolling stock on a heavy steel railway would reveal the necessity of a reconsideration of the relationship of the wheel and track, yet no one seems to have been bold enough to tackle the problem and obtain the best design of wheel.

The writer does not suggest that there may not be other factors to consider, but would merely point out the enormous loss and disadvantages that arise from the conical form of wheel tread at present in use; these may be summarized as follows:

1 *Loss of Power Due to the Compelling of a Conical Surface to Roll in a Straight Line.* If in an ordinary railway wheel the mean bearing surface of the rail on the flange gives a difference of circumference of 0.86394 in. and this difference has to be accounted for by an acceleration above the normal speed of revolution of the outer bearing line, or an equal retardation of the inner bearing line, of the tread; normally and presumably the difference should be divided, but in any case the skidding of the wheel metal is such as to require the application of 8910.8 ft-lbs. of work per ton per mile, over and above the ordinary effort of traction; and is moreover the circumstance that increases so enormously the starting effort required in rolling stock.

2 *The Wear and Tear Due to the Same Conditions.* The profile of the ordinary rail is such as to give initially a line bearing but it is not very long (two or three months in the case of tramways), before the rails are ground down to the tread profile and thence onward the grinding effort is equivalent to that calculated in (1), moreover in the street tramways the ordinary grind of metal on metal is enhanced by the interposition of street grit, foreign matter between the wheel and rail.

3 *The Elimination of Noise.* The writer was interested in a length of relaid tramway track and was surprised at the absence of noise so long as the wheel ran on the rails with narrow bearings, which was due to the tread of the wheel being straight and the rail top curved; but on reflection it is evident that the grind of steel on steel must necessarily create much of the usual noise associated with tramways and railways.

4 *Corrugation of Rails.* It must be quite obvious that in (comparatively light) resilient tramway rolling stock the chatter due to the slipping of one part of the wheel tread must cause a jump resulting in corrugations, but there must also be a certain synchronism developed due to some local peculiar feature of the track.

It was recently argued that once the rail became worn to the conical profile of the wheel tread, the principles enunciated above would not hold and that the New South Wales Railway Department canted the rails 1 in 20 to compensate for the coning, but geometrically it can be demonstrated that as long as the wheel tread is formed conical nothing will eliminate the disastrous factors enumerated; the best proof however, is to draw a wheel diagram with two treads, the inner one of the larger diameter and the outer one of the smaller diameter, and apply this to a rail stepped with a difference of the two radii, to allow each tread to bear; obviously one or other of the treads must grind.

The fillet of the ordinary wheel design is also a serious loss of power, as what applies to the cone applies equally and to a further extent (proportional to the radii of the similar lines of the fillet curve) to any part of the fillet bearing downward on the rail.

Sydney, N. S. W. F. ERNEST STOWE.[1]

TO THE EDITOR:

The question raised by Mr. F. E. Stowe on the proper contour of the wheel tread whether initially coned or flat and train resistance loss resulting therein, is a matter worthy of further discussion.

Let us first consider the theoretical loss of energy resulting when perfectly coned wheels are displaced laterally a distance y from their central position and compelled to rotate in a longitudinal direction. If $1/n$ is the taper of the coned wheel and r the mean radius of the

[1] Civil and Consulting Engineer; M.I.E. (Aus.); Mem. Am.Soc.M.E.

wheels, then for the radii of the outer and inner wheel tread we have—

$$r_1 = r + \frac{y}{n} \text{ and } r_2 = r - \frac{y}{n}$$

If w = angular velocity of the wheels and v = velocity of translation of the axle, then $v = wr$ and the relative velocity or slippage velocity between tread and rail is—

$wr_1 - v$ = backward slippage of tread for outer wheel (ft. per sec.)
and
$v - wr_2$ = forward slippage of tread for inner wheel (ft. per sec.)

Therefore if u is the coefficient of friction and N the normal wheel

FIG. 1.

FIG. 2.

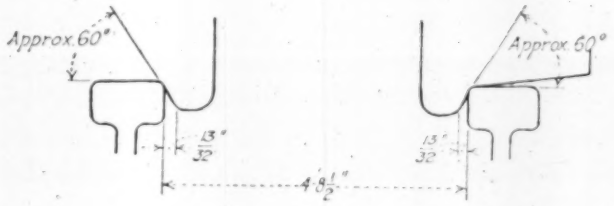

FIG. 3.

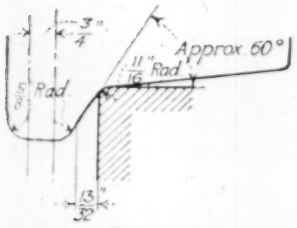

FIG. 4

FIG. 5.

load, the friction forces at the base of treads are approximately equal to uN (lb.) and act forward on the outer wheel and backward on the inner wheel tread. The loss due to slippage is—

$$A_s = uN \left\{ (wr_1 - v) + (v - wr_2) \right\} = \frac{2uNwy}{n} \text{ (ft-lb. per sec.)}$$

$$\therefore A_s = \frac{2uNvy}{rn} \text{ (ft-lb. per sec.)}$$

While the maximum possible train resistance per ton, with coefficient of friction $1/5$ is—

$$P_s = \frac{400y}{rn} \text{ (lb. per ton), approximately.}$$

The preceding results are based on estimating the relative work of slippage. For a better conception of the reactions involved in this slippage, the following analysis is of interest. Though the frictional forces for the outer and inner wheels at tread base are approximately equal and opposite, they cannot be the same due to the different radii of the treads, and it is due to their resultant differential effect which causes the drawbar resistance required for a given axle. If the wheel is moving with uniform motion, we have no angular acceleration and therefore, if F = total friction at base of outer tread and F' = total friction force at base of inner tread, we have,

$$Fr_1 = F'r_2 \text{ and } F' = \frac{r_1}{r_2} F \text{ (lb.)}$$

The axle resistance exerted at the journal bearings due this cause is—

$$P_s = F' - F = F\left(\frac{r_1 - r_2}{r_2}\right) \text{ (lb.)}$$

and the power loss is—

$$A_s = F\left(\frac{r_1 - r_2}{r_2}\right) v \text{ (ft-lb. per sec.)}$$

As a check, based on the relative work of friction, using the exact friction forces, we likewise have, as before,

$$A_s = F(wr_1 - v) + F'(v - wr_2) = F\left(\frac{r_1 - r_2}{r_2}\right) v \text{ (ft-lb. per sec.)}$$

Obviously these expressions reduce approximately to the values given above.

Fig. 1 shows the tread contour of the M. C. B. standard. The taper at the tread is 1 : 20 and if we assume a total flange play of $^3/_4$ in., $y = 0.375$ in. Hence the maximum train resistance per ton due to cone slippage of a new wheel is—

$$F_s = \frac{400 \times 0.375}{r \times 20} = \frac{7.5}{r} \text{ (lb. per ton)}$$

With an ordinary 36-in. car wheel this amounts to—

$F_s = 0.4166$ lb. per ton, or to $0.4166 \times 5280 = 2200$ ft-lb. per ton-mile.

Figure 2 shows the ultimate wear of a tread. From this it is evident that the contour of the tread soon changes from a conical surface to a flat bearing surface. The coning of wheels probably resulted in the early development with the idea of causing the axle to run radially around a given curve. Since the radius of curvature R for a given coning is $(G/2) \times (rn/y)$, where G is the track gage, it is evident that there can be only one curvature for a given theoretical coning. Thus the practical value of coning amounts to allowing a wearing depth for the new wheel, and this alone would seem to justify the continuing of this practice. The losses due to coning with a new wheel are at best relatively small; the maximum possible train resistance for full lateral displacement of the axle not exceeding $^1/_2$ lb. per ton. The average loss, since the mean of the lateral displacements is likely much less, would not probably exceed one-third of this value or $^1/_6$ lb. per ton. Roughly the total train resistance at slow speeds is 5 lb. per ton, therefore the slippage due to the coning of a new wheel is only from 3 to 4 per cent of the total friction and much less at higher speeds. Even assuming a very high coefficient of friction, the slippage due to coning could not account for more than 10 per cent of the total starting resistance.

It is of interest to point out other losses due to the contour of the wheel tread. At high speeds the flange is brought intermittently in contact with the rails first on one side and then on the other and the lateral reaction exerted at the flange is a function of several variables, including the elastic lateral resilience of the rail. Let the mean lateral be Y. With a small obliquity of the wheel, the flange contact takes place at the tread of the wheel. Let r' be the radius of the arc of contact of wheel flange and rail and ϕ the angle to any differential area of contact along the radius r' with respect to the horizontal. Then,

$$P = \int_0^{\pi/2} \frac{upr'd\phi \cos\phi \; r' \; (1 - \sin\phi)}{r}$$

where $p = Y/r$ and u = coefficient of friction. Since the projected bearing pressure in the direction of Y must always equal the actual bearing pressure, therefore

$$P = \frac{uYr'}{r} \int_0^{\pi/2} \cos\phi \; (1 - \sin\phi) \; d\phi = \frac{uYr'}{2r}$$

The reduction of the radius of the fillet tends to increase the depth of flange contact r', and in the wear the mean flange friction increases. Other considerations are a sufficient flange fillet to reduce high local stresses due to large lateral flange reactions. The mean value of the lateral reaction Y on tangent track is very indefinite, but it increases very rapidly with the speed.

Another cause of slippage loss is due to a slight obliquity of the axle when held in the boxes of the frame. Then the peripheral velocity of the wheel makes a small angle θ with the rail tangent. The friction force resulting from this cause in the longitudinal direction is evidently,

$$uW \tan\theta = uW\theta \text{ approx. (lb.)}$$

whereas the work done is—

$$uWv \tan\theta = uW\theta v \text{ (ft-lb. per sec.)}$$

where W is the axle rail load. With poor alignment of axles, this loss may reach appreciable values.

Contour of Wheel Flange and Tread in Practice. Figs. 3 and 4 show the essential contour of a new wheel and Fig. 5 the final wearing limit. We see, therefore, that the tread taper is quite justified in giving additional wearing depth and preventing the wheel after wear from having an excessive reversed taper. The mean life of the tread is actually on a flat surface. With a new wheel for the friction loss to be appreciable with a given coning, we must have a definite lateral displacement. This, however, is prevented, since the throat fillet is brought in contact with the rail and a large lateral reaction is exerted which results in centralizing the axle. With a new wheel and worn rail or with a slight spread of the rails a small lateral displacement is possible, but in the previous discussion the losses shown even in this case are relatively small. Hence the taper is justified in giving a good contour for the tread for average wear.

The dimensions of the flange and the flange fillet are based on wear and strength and proper contour to prevent derailment. For wear and strength a large fillet is desirable, whereas on the other hand too large a fillet will make the slope at the point of tangency to the flange top circle too small. The slope in practice is about 60 deg. and this corresponds to a fillet of radius $^{11}/_{16}$ in. and top flange circle of radius $^{5}/_{8}$ in. in an ordinary car wheel. Such a contour wears to a straight flange with a minimum thickness at root of flange equal to $^{15}/_{16}$ in. and total depth of $1^{1}/_{2}$ in. The value of the lateral flange reaction Y in terms of the normal wheel load N is given by the expression—

$$Y = N\left[\frac{\tan\phi - u}{1 - u\tan\phi}\right] \text{(lb.)}$$

where ϕ is the slope angle. To show the importance of the slope angle and the coefficient u, the ratios of N/Y are given below:

u	$N/Y = 45°$	$N/Y = 60°$
0.0	1.000	0.577
0.1	1.221	0.718
0.2	1.500	0.874
0.3	1.860	1.058

Thus with an excessive fillet resulting in a low slope, say, 45 deg. the axle load must be roughly $2 \times 1.86 = 3.72$ times the lateral reaction required to prevent derailment, whereas with a standard wheel with a smaller fillet the axle load required is $2 \times 1.058 = 2.116$ (min.) times the required lateral reaction. With a smaller fillet the life of the wheel is shortened. It is well to maintain axle loads from 2.5 to 3.0 times the maximum guiding reaction.

In conclusion, it would seem that our standard practice for wheel contour is very much justified from theoretical aspects as well.

Philadelphia, Pa.* R. EKSERGIAN.

Second Revision of A.S.M.E. Boiler Code, 1922

A HEARING is held by the Boiler Code Committee at least once in four years, at which all interested parties may be heard, in order that such revisions may be made as are found to be desirable, as the state of the art advances. The year 1922 becomes the period of the second revision, the first revised edition of the Boiler Code having been issued in 1918. The Boiler Code Committee plans to hold a Public Hearing in connection with the next Annual Meeting of the Society in December, 1922, to which the membership of the Society and everyone interested in the steam-boiler industry will be invited and where they may present their views.

In the course of the Boiler Code Committee's work during the past four years, many suggestions have been received for revisions of the Power Boiler Section of the Code, as a result of the interpretations issued and also of the formulation of the Locomotive Boiler and Miniature Boiler Codes. In order that due consideration might be accorded to these recommendations, the Committee began in the early part of 1921 to devote an extra day at each of its monthly meetings to the consideration of the proposed revisions. As a result of this many of the recommendations have been accepted and revisions of the paragraphs formulated.

The revisions which have met the approval of the Boiler Code Committee are here published. It is the request of the Committee that these revisions be fully and freely discussed so that it may be possible for anyone to suggest changes before the rules are brought to final form and presented to the Council for approval. Discussions should be mailed to C. W. Obert, Secretary to the Boiler Code Committee, 29 West 39th St., New York, N. Y., in order that they may be presented to the Boiler Code Committee for consideration.

The revisions here published are limited to the paragraphs appearing in the 1918 Edition of the A.S.M.E. Boiler Code, and the paragraph numbers refer to the paragraphs of similar number in that edition. For the convenience of the reader in studying the revisions, all added matter appears in small capitals and all deleted matter in smaller type.

PAR. 194 REVISED:

194 *Domes.* THE REQUIREMENTS OF PARS. 187 AND 188 SHALL APPLY TO RIVETED LONGITUDINAL JOINTS OF DOMES EXCEPT THAT FOR DOMES 24 IN. AND LESS IN DIAMETER FOR PRESSURES EXCEEDING 100 LB., THE LONGITUDINAL JOINTS MAY BE LAPRIVETED IF THE FACTOR OF SAFETY IS NOT LESS THAN 8. [The longitudinal joint of a dome 24 in. or over in diameter shall be of butt and double-strap construction, irrespective of pressure. When the maximum allowable working pressure exceeds 100 lb. per sq. in., the flange of a dome 24 in. or over in diameter shall be double-riveted to the boiler shell.]

THE FLANGE OF A DOME 24 IN. OR OVER IN DIAMETER SHALL BE DOUBLE-RIVETED TO THE BOILER SHELL. WHERE THE FLANGE OF THE DOME IS USED FOR REINFORCING OR ATTACHING IT TO THE SHELL, THE DIAMETER OF THE DOME SHALL NOT EXCEED ONE-HALF THE DIAMETER OF THE SHELL OR BARREL OF THE BOILER. [The longitudinal joint of a dome less than 24 in. in diameter may be of the lap type, and its flange may be single-riveted to the boiler shell provided the maximum allowable working pressure on such a dome is computed with a factor of safety of not less than 8.]

The dome may be located on the barrel or over the fire-box on traction, portable or stationary boilers of the locomotive type. [Up to and including 48 in. barrel diameter. For larger barrel diameters, the dome shall be placed on the barrel.]

Flanges of domes shall be formed with a corner radius, measured on the inside, of at least twice the thickness of the plate for plates 1 in. thick or less, and at least three times the thickness of the plates for plates over 1 in. in thickness.

PAR. 244 REVISED:

244 The thickness of a corrugated or ribbed furnace shall be ascertained by actual measurement BY THE FURNACE MANUFACTURER BY GAGING THE THICKNESS OF THE CORRUGATED PORTIONS. IF A HOLE IS DRILLED THROUGH THE SHEET TO DETERMINE THE THICKNESS IT SHALL BE $^{3}/_{8}$ IN. WHEN THE FURNACE IS INSTALLED THE HOLE SHALL BE LOCATED BENEATH THE BOTTOM OF THE GRATE AND CLOSED BY A PLUG. The furnace shall be drilled for a $^{1}/_{4}$-in. pipe tap and fitted with a screw plug that can be removed for the purpose of measurement. For the Brown and Purves furnaces, the holes shall be in the center of the second flat; for the Morison, Fox and other similar types, in the center of the top corrugation, at least as far in as the fourth corrugation from the end of the furnace.

PAR. 254 REVISED:

254 After drilling or reaming rivet holes the plates and butt straps OF LONGITUDINAL JOINTS shall be separated, the burrs and chips removed, the plates and butt straps reassembled metal to metal with barrel pins fitting the holes, and with tack bolts.

PAR. 265 CHANGE CENTER HEADING ABOVE THIS PARAGRAPH TO:

WASHOUT [HOLES] OPENINGS

PAR. 287 REVISED:

287 When the valve body is marked [with the letters A.S.M.E. Std.] as required by Par. 273, this shall be a guarantee by the manu-

Note: Matter deleted, in smaller type; matter added, in small capitals.

facturer that the valve conforms to the details of construction herein specified.

PAR. 294 REVISED:

294 Each boiler shall have three or more gage cocks, located within the range of the visible length of the water glass, except when such boiler has two water glasses with independent connections to the boiler and located on the same horizontal line and not less than 2 ft. apart. LOCOMOTIVE-TYPE BOILERS NOT OVER 36 IN. IN DIAMETER NEED HAVE BUT TWO GAGE COCKS.

PAR. 303 REVISED:

303 When two or more boilers HAVING MANHOLE OPENINGS are connected to a common steam main, two stop valves, with an ample free-blow drain between them, shall be placed in the steam connection between each boiler and the steam main. The discharge of this drain valve must be visible to the operator while manipulating the valve. The stop valves shall consist preferably of one automatic non-return valve (set next the boiler) and a second valve of the outside-screw and yoke type; or, two valves of the outside screw and yoke type may be used.

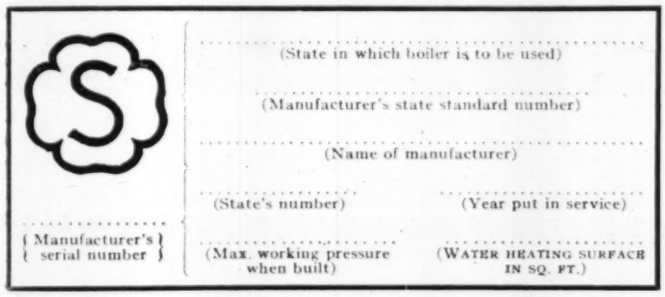
S
(State in which boiler is to be used)
(Manufacturer's state standard number)
(Name of manufacturer)
(State's number)
(Year put in service)
(Manufacturer's serial number)
(Max. working pressure when built)
(WATER HEATING SURFACE IN SQ. FT.)

FIG. 24 FORM OF STAMPING

PAR. 315 REVISED:

315 In a horizontal [return] tubular EXTERNALLY FIRED FIRE-TUBE boiler the feedwater shall discharge ABOVE THE CENTER ROW OF TUBES at about three-fifths the length from the front head (except a horizontal [return] tubular boiler equipped with an auxiliary feed-water heating and circulating device), above the central rows of tubes OR FLUES, when the diameter of the boiler exceeds 36 in. The feed pipe shall be carried through the FRONT head or shell [near the front end] in the manner specified for a surface blow-off in Par. 307, and be securely fastened inside the shell above the tubes.

IN THESE AND other types of boilers where both internal and external pipes making a continuous passage are employed, the boiler bushing or its equivalent shall be used.

In Fig. 22 is illustrated a typical form of flange for use on boiler shells for passing through piping such as feed, surface, blow-off connections, etc., and which permits of the pipes being screwed in solid from both sides in addition to the reinforcing of the opening in the shell.

PAR. 318 REVISED:

A BOILER HAVING MORE THAN 500 SQ. FT. OF WATER-HEATING SURFACE SHALL HAVE AT LEAST TWO MEANS OF FEEDING, ONE OF WHICH SHALL BE A PUMP, INSPIRATOR OR INJECTOR. WHERE A SOURCE OF FEED IS AVAILABLE AT A SUFFICIENT PRESSURE TO FEED THE BOILER AGAINST A PRESSURE 6 PER CENT HIGHER THAN THAT AT WHICH THE SAFETY VALVE IS SET TO BLOW, THIS MAY BE CONSIDERED ONE OF THE MEANS. [When a pump, inspirator or injector is required to supply feedwater to a boiler plant of over 50 h.p., more than one such appliance shall be provided.]

PAR. 332 CHANGE TABULATION AT END OF PARAGRAPH AND FORM OF STAMPING AS FOLLOWS:

1 Manufacturer's serial number
2 State in which boiler is to be used
3 Manufacturer's state standard number
4 Name of manufacturer
5 State's number
6 Year put in service
7 Maximum working pressure when built
8 WATER HEATING SURFACE IN SQ. FT.

Items 1, 2, 3, 4, 7 AND 8 are to be stamped at the shop where built.

Items 5 and 6 are to be stamped by the proper authority at point of installation.

PAINT PROTECTION FOR WOOD

(*Continued from page 520*)

that rubs off the layer of rust and exposes the nail to continuous corrosion. The working also abrades the wood and leaves the familiar large, rust-stained hole around an attenuated nail. The same conditions apply to the bolts and other steel fastenings in farm machinery, wagons, motor-truck bodies, and a long list of other articles. It is of vast importance in wood construction, therefore, that we have paints to protect the wood from absorbing moisture. Ordinary paint does not effectively do this except when a large number of coats is applied, and so far as the writer has been able to find out, there has been little or no attempt to produce a paint that will do it.

In the realm of house painting there seems to be a great possibility for economies, either by the use of cheaper paints which will give the necessary protection, or by the use of paints which will last longer. The writer is not familiar enough with this subject to warrant any comments other than to refer to Dr. A. H. Sabin's letter to the *Engineering News-Record* of August 18, 1921, in which he states that even the Pennsylvania Railroad is not always able to protect itself in the matter of paints, and he asks what chance the ordinary citizen has to check up on the paint he should use to protect the house that very possibly represents his life's savings. Paint literature of a technical nature is of no assistance to the average man, and is quite inadequate to explain the why and wherefore of much present practice. Great differences of opinion and some vague reasoning appear. Many contentions seem to be based on a desire to use certain materials or formulas, rather than on comparative service data of a reliable sort. Such men as Dr. Sabin of the National Lead Co., and Dr. Holly of Acme White Lead and Color Works, made frank acknowledgment of the shortcomings of paint technology and totally disavow any detail information concerning the effect of paints on moisture-proofing the cell structure of woods of various kinds. The Engineering Foundation has approved the desirability of this research and has appointed a committee to report ways and means of furthering it. This is a most substantial endorsement. The Society of Automotive Engineers and the American Institute of Architects have also approved and will lend their support.

It would seem that an intimate knowledge of wood cell structure is essential to any investigation of this subject. The Forest Products Laboratory is by all odds our most authoritative source of information on woods and their structure. The Director and his staff have been interviewed and fully agree that this research would be productive of important results, some of which could be expected in the course of 8 to 12 months; also that it can be handled there if funds in a very modest amount, between $10,000 and $20,000 per year, were made available for, say, from five to ten years. The Bureau of Standards has a paint division and has funds to work on the paint end of the research. Doubtless a coöperative arrangement could be made between these two of the most capable and helpful arms of our governmental service. Doubtless, too, the technical heads in the paint and varnish trade would place at the disposal of the Bureau of Standards and the Forest Products Laboratory their great fund of knowledge of paints and oils. Many of these men are already working on this problem, as has been set forth above; but they are handicapped by a lack of intimate knowledge of the various kinds of woods, and they are very much limited both in the time they can give and in the range of materials which they can test.

There is a crying need for such information, and inside of a year after the work is started a considerable amount of usable data should be forthcoming. The difference between the insignificant cost of the research and its value to the country at large is so vast that the writer believes it is only necessary to call attention to the matter in order to institute a widespread demand for action.

MECHANICAL ENGINEERING

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Standardization

THE subject of standardizaton is now receiving much attention in all lines of industry and in all countries. Needless to say, such a universal question has many sides, and many varying and differing opinions are held as to the nature and extent of proper standardization. A very unusual and striking address on this subject was given recently by Mr. Albert W. Whitney, Chairman of the American Engineering Standards Committee before the National Construction Conference at Chicago. After pointing out the misconception that standardization will tend towards a world reduced to sameness, he continues:

> The difficulty will disappear if we realize three things about standardization: first that it does not belong with the vanguard, it comes along in the rear just ahead of the commissary department; second it is not exclusive, it does not attempt to pick out the one best, it picks out instead, many that are good; and third its judgments are not final but tentative and ever open to revision.
>
> In the march of progress the way is led by the visionaries, those who get the first gleam of the idea, the prophets, the artists, and the inventors; their heads are in the clouds but their feet are not always on the ground and so they have to be followed by minor prophets and minor artists and minor inventors who can capture the idea and tame it; then comes an army of critics and exploiters and executives, and at last the idea is put to work. But it doesn't work smoothly; the prophets and minor prophets and even the executives, who ought to know better, have left the ground in confusion. The good ideas are lost among a litter of impossible ideas, half-baked ideas, and ideas in every stage of futility. Somebody must come along and clear up, save what is good and throw the rest into the discard. This is the humble job of the standardizer.

This outline of the work of the standardizer will not be accepted universally. For one thing, it is not the duty of standardization to throw anything into the discard. Any given standard, to achieve its object, must meet the conditions of service in the majority of cases as well as, or better, than any other construction or practice would meet them. Yet after this is accomplished, exceptional conditions arise which no standard will meet properly. Every published standard might properly be prefaced with the remark, "Exceptional cases require special consideration." Thus many of the practices and constructions which are not suitable for general use, fill their own peculiar niche. On the other hand, the promulgation of logical standards will develop practice along unified lines, thus eliminating by an evolutionary process many slightly dissimilar ones.

Also, standardization deals with more concrete things than ideas. A large number of similar practices or constructions must be in general use before a need or demand for standardization exists.

Mr. Whitney goes on to describe the effects of standardization upon the processes of production and distribution.

> When deep thinkers and all their class find themselves free of the confusion created by the very fertility and multiplicity of their own ideas, they find that they can turn over the whole subject to a still more minor caste, those who look after routine. For instead of designing a truss or a belt or a generator or a fire-escape, the engineer has now only to specify a certain standard type or certain standard features that have already been worked out and the detail can then be left to subordinates.
>
> Now the prime importance of this upon progress is partly the acceleration and economy and convenience and efficiency that has therefore been produced, but to an equal degree it is due to the fact that the attention and energy of those who are on the frontier of knowledge has been set free for still further forays into the unknown.

Many machine designers object to the use of standard parts and constructions because they claim it robs them of initiative and originality. As a matter of fact, standardization in this field can never cover more than the relatively unimportant details. The use of standards, therefore, instead of hindering them, will free them from this minor detail and give them much more time and effort for creative work.

> With the thought well established then that standardization, if properly applied, not only does not interfere with the initiative and spiritual freedom upon which art and progress must depend, but is the very soil upon which they grow, may I now direct your attention to the wonderful things that this soil can produce.
>
> The result of throwing processes into the field of routine that have heretofore required explicit mental effort not only sets free this mental effort for other purposes, but makes possible mass-production; and indeed mass-production is impossible without standardization. In the opinion of Mr. Hoover and other students of industry, greater mass-production is necessary under our present post-war conditions if we are to maintain our standard of living and if we are to compete successfully with European industry. The relation between standardization and economy and efficiency in production is too plain to require further consideration.
>
> We may definitely make up our minds that we are beyond the era of the craftsman as respects the basic elements of our individual life. The era of machinery, if its peculiar genius is to be developed, leads us to standardization and mass-production. We still need the craftsman, but his place has been moved on into the field of finer values. It is the underlying basic elements of industry that I am discussing; in this field standardization, simplification, and mass-production must be developed to the greatest possible extent.

Exception may be taken to the statement that we are beyond the era of the craftsman. This may be due to the particular meaning that Mr. Whitney attached to this term. To my mind, the term "craftsman" has a peculiar significance. It implies not merely manual skill but also pride and interest in the work of the hands. It is true that in the productive departments of plants engaged in mass-production specialists rather than general mechanics are needed. Nevertheless there is great need of craftsmen among these specialists. No labor is so elementary that the spirit of craftsmanship is not needed for the best results.

> We are inclined to feel that the benefits of standardization apply mainly in the field of production. This is not so. They are quite as important both in the field of selling and of buying.
>
> The carrying in stock of the wide variety of sizes and grades that have grown up in a given field under the influence of the blind forces of demand, however casual, and competition, however misguided, has not only tied up an immense amount of capital but has taxed storage facilities and slowed up delivery. It is on record that an agricultural-implement house has recently been unable to make delivery of three carloads of wagons in spite of the fact that it had 12,000 wagons in stock. It is not too much to say that in most lines of business the variety that is found in stocks could be cut down to one-tenth of what it now is and serve perfectly well all reasonable demands. But it is the buyer quite as much as the producer and distributor that profit by standardization. The ordinary buyer is not an expert and he is therefore very largely at the mercy of the seller. He is not able to form an independent judgment of the quality and value of the goods that are for sale and he must therefore either buy in the dark or he must follow the advice of the seller. But if goods are standardized and marked so that they can be identified, it is possible for the buyer to familiarize himself with these standard lines, particularly if the unnecessary variety has been eliminated. He thus becomes an intelligent buyer; his purchases have greater utility and his discrimination reacts favorably upon the distributor and producer.
>
> And now having given you a very sketchy picture of the possibilities of standardization, I will tell you something about the agencies that are engaged in bringing it about.
>
> Unquestionably the most significant and promising event in the recent development of the standardization movement has been the entrance into the field of the Department of Commerce through the Division of Simplified Practice, newly organized by Secretary Hoover and in charge of Mr. W. A. Durgin, recently of the Commonwealth Edison Company of Chicago.

The other outstanding factors in the situation are doubtless the Bureau of Standards, which for years has done such fine fundamental work, the U. S. Chamber of Commerce, Division of Fabricated Production, which has been active in arousing interest among trade organizations; and the American Engineering Standards Committee; although there are a multitude of other bodies which are taking an important interest in the movement.

When a standard is approved by the American Engineering Standards Committee, it becomes known as an American Standard or as a Tentative American Standard and through no mandatory process, but because of the standing and representative character of the American Engineering Standards Committee, such standards become to a considerable extent adopted by industry and the Government. The American Engineering Standards Committee has approved nineteen standards and has sixty-two other projects under way.

No standard is ever widely adopted because of the standing or representative character of the body which promulgates it. In the final analysis, a standard is adopted or rejected on its own intrinsic merits. The character of the body which issues them has much to do with their early trial, but their final acceptance depends entirely upon their worth.

EARLE BUCKINGHAM.

Southern Appalachian Water Power Conference Establishes Permanent Organization

At a meeting held in Asheville, N. C., June 20 to 22, 1922, a permanent Southern Appalachian Water Power Conference was established to study the water-power resources of the Southern Appalachian region and their relation to industrial growth and navigation. Joseph Hyde Pratt, director of the North Carolina State Geological Survey was elected as the first president. The other officers are Lincoln Green, vice-president of the Southern Railway, vice-president; J. A. Switzer, secretary; and Professor Thorndyke Saville of the University of North Carolina, assistant secretary and treasurer. All the states south of the Ohio and Potomac rivers and east of the Mississippi are to be gathered into this Conference.

O. C. Merrill, secretary of the Federal Power Commission, presided over the Conference Sessions at which the speakers stressed the importance of basic information about stream flow, rainfall, etc., in order to hasten the development of water power with its resulting effect on the future of industry and transportation.

Charles E. Waddell of Asheville, N. C., in a communication to Secretary Rice of the A.S.M.E., emphasized the remarkable interest shown by the body of public-utility executives and engineers who gathered to discuss the subject of Southern Appalachian Water-Power Resources.

American Construction Council Organizes

Under the initial chairmanship of Secretary of Commerce Herbert Hoover, the American Construction Council was formally organized in Washington, D. C., on June 19, 1922. More than 200 men, representing 54 associations interested in the construction industry, attended the meeting.

The purpose of the Council is to place the construction industry on a high plane of integrity and efficiency and to correlate the efforts toward betterment through a conference association, representative of the whole industry and dedicated to the improvement of the service which the construction industry renders. It has included in its organization all the elements of industry, each with voting power. There are eleven groups: architects, engineers, general contractors, sub-contractors, construction labor, manufacturers, dealers, financial, bond and insurance interests, public utility construction departments, construction departments of federal, state and municipal governments, and building exchanges. Each group has four representatives on the executive board.

In his address at the opening session Chairman Hoover said that he believed the Council would help to stabilize the industry and eliminate undue speculation. He characterized the movement as one of the most important steps taken in the history of the industry. Walter Gordon Merritt, speaking on Determining the Proper Relations between the Several Elements of the Construction Industry, said that the Council must function so that constant coöperation between employer and employee must replace the "periodic armistices" which are now the history of their relations. He declared that the trouble with the industry now is due not to lack of organization but to organization with selfish motives. The Council must replace selfishness by a sense of responsibility to the public.

The second day of the meeting was taken up with discussion of what the Council might do to further the aims of the several groups. Committees were appointed on: code of ethics, seasonal unemployment, apprenticeship, building codes, transportation rates, publicity, simplification, standardization and waste elimination, and methods to be pursued in gathering statistics.

In discussing the finances of the organization, it was freely expressed that the Council would not be living up to its opportunities if in three years its annual budget was less than $250,000. No conclusion on the method of financing, other than by dues, was reached.

Upon the adjournment of the meeting the executive board went into session and elected Franklin D. Roosevelt, formerly Assistant Secretary of the Navy, president, and John B. Larner, president of the Washington Loan & Trust Co. and vice-president of the American Bankers' Association, treasurer.

Calvert Townley, Past-President of the American Institute of Electrical Engineers, spoke at the opening session, representing the engineering profession. The executive board members of the engineers' group are: C. T. Main, Boston; B. J. Arnold, Chicago; Peter Junkersfeld, New York; and C. F. Loweth, Chicago.

Engineering Council Takes Up Forest Conservation

It is self-evident that the preservation of forests is vital to future hydroelectric development as well as to the timber supply, soil conservation and flood retardation. These are all of importance to our civilization and of extreme interest to engineers. The American Engineering Council has a committee which will investigate conditions and take suitable action looking toward proper state and national legislation for forest preservation. This committee consists of Charles H. MacDowell of Chicago, chairman, S. H. McCrory of the Department of Agriculture, Washington, D. C., W. H. Hoyt of Duluth, Minn., and J. C. Ralston of Spokane, Wash.

The committee is investigating forestry conditions in all the states and has already received reports of the existing situation together with recommendations of the state forestry for measures of relief in what is described as "a critical period" in the development of a national policy of reforestation. Many of these recommendations center on fire prevention, development of nurseries, roadside tree planting, the supplying of proper stock for state and private reforestation, encouraging private reforestation through elimination of excessive taxes, new planting on public lands not suitable for tillage, whether federal or state owned, support of certain forestry bills now in Congress, and the encouragement of reforestation by coöperation between federal and state authorities.

France Awards Dr. A. E. Kennelly Cross of Legion of Honor

For distinguished services rendered as exchange professor in engineering to the French Republic, the Cross of the Legion of Honor has recently been awarded to Dr. A. E. Kennelly, professor of electrical engineering at Harvard University and the Massachusetts Institute of Technology. This honor may be conferred for meritorious service to the French Republic in military or civil life.

Dr. Kennelly was the first exchange professor sent to France from America under the scheme of regular annual exchange of professors in engineering and applied science, inaugurated last fall between the French University Administration and seven American institutions. The French representative in America, Professor J. Cavalier, rector of the University of Toulouse, and an authority on metallurgical chemistry, has recently returned to France after a year spent at the seven coöperating institutions, Columbia, Cornell, Harvard, Johns Hopkins, Massachusetts Institute of Technology, Pennsylvania and Yale.

The award of the Cross of the Legion of Honor to Dr. Kennelly is an indication of the success of the scheme for an exchange professorship in engineering. The undertaking will undoubtedly increase the mutual understanding between French and American engineers, and have a broadening effect on the profession.

NEWS OF OTHER SOCIETIES

AMERICAN SOCIETY FOR TESTING MATERIALS

Thirty-five standing committees of the American Society for Testing Materials, all of which had been at work during the year revising present specifications and formulating new ones, presented reports at the twenty-fifth annual meeting of the Society held in Atlantic City June 26–30. Study of materials and test methods, for the first time in the history of the Society, took preference over specification work. The most important single item of the program so far as this new phase of activity is concerned was two sessions in which impact testing of materials and fatigue phenomena were discussed. The papers and discussions brought out the fact that there is not available as much definite information on impact testing as is desirable, and the Society plans to remedy this deficiency by making a thorough study of the subject in the future.

Sessions were held on Non-ferrous Metals and Corrosion, Steel, and Wrought, Gray and Malleable Iron. At the latter session revised specifications for foundry pig iron and for chilled cast iron were suggested by Committee A-3 of which Richard Moldenke, a member of the A.S.M.E., is chairman.

The newly elected President, G. K. Burgess, in his address said that the executive committee is considering ways and means of further circulating the Proceedings of the Society in foreign countries so that the American standards may become more generally known. An indication of the extent to which the standards are used in this country is shown by the fact that last year $18,000 worth of the Society's literature was sold.

The annual golf tournament was won by F. G. Breyer and the tennis tournament by R. W. Seabury. Officers elected in addition to the President, Mr. Burgess, are W. H. Walker, Vice-president, and W. K. Hatt, J. R. Onderdonk, D. M. Buck, and W. M. Corse, new members of the Executive Committee.

AMERICAN RAILWAY ASSOCIATION

The third annual meeting of the American Railway Association was held in Atlantic City June 14–21. The Mechanical Division held its sessions during the first three days. Reports were presented on the cost of labor and materials, arbitration, tank cars, loading rules, train lighting and equipment, car construction, couplers and draft gears, brake-shoe and break-beam equipment, train-brake and signal equipment, and car wheels.

The exhibition this year was one of the largest ever attempted by the Railway Supply Manufacturers' Association. In addition to machine tools and shop equipment, practically all kinds of railway equipment were exhibited, from complete locomotives and cars to the small devices used in the construction of railway rolling stock. There were in all about 350 exhibitors and 100,000 square feet devoted to exhibit space.

The attendance was large and representative of the membership of the division, which comprises the former Master Car Builders and Master Mechanics Associations. Headquarters were at the Marlborough-Blenheim Hotel, where the technical sessions were held.

AMERICAN FOUNDRYMEN'S ASSOCIATION

The twenty-sixth annual convention and exhibition of the American Foundrymen's Association, held in Rochester, N. Y., June 5 to 9, marked an epoch in the history of the Association in that it presented the first specially planned international session. Representatives of the foundry associations of Great Britain, France and Belgium took part in the session, which was a signal success. The feature among the technical papers at this meeting was the exchange paper from a member of the British Foundrymen entitled American Versus British Cast Iron, by F. J. Cook, Rudge-Littley, Ltd., Birmingham, Eng., Past-President of the Institute of British Foundrymen.

Two sessions were held on steel-foundry subjects and eleven papers and reports were presented. Interesting sessions were held on gray-iron topics, malleable iron and molding sand, industrial relations, and four sessions on non-ferrous matters were held as joint meetings with the Institute of Metals Division of the American Institute of Mining and Metallurgical Engineers which was holding a concurrent meeting.

The attendance and registration at both the technical sessions and exhibition were large, having been exceeded on only two previous occasions. The exhibition, although not the largest, was one of the most representative ever held. There were 173 exhibitors and the compact arrangement and the impression of unity were favorable factors. The exhibition was held in Exposition Park, not far from the buildings in which the technical sessions were held.

Officers elected for next year include C. R. Messinger, President; G. H. Clamer, Vice-president; and C. B. Connelley, Fred Erb, L. W. Olson and A. B. Root, Jr., Directors.

SOCIETY OF AUTOMOTIVE ENGINEERS

The semi-annual meeting of the Society of Automotive Engineers was held at White Sulphur Springs, West Va., June 20 to 24. A feature of the meeting was the report from a sub-committee on methods of numbering cars and engines so that obliteration or change of the numbers would be impossible without easy detection. The committee had had samples made up to test several of the most promising suggestions, but admitted that it had been somewhat surprised by the ease with which all of them had been beaten by the Underwriter's Laboratories.

At the meeting of the Standards Committee, reports were presented from the following divisions: Agricultural Power Equipment, Axle and Wheel, Electrical Equipment, Engine, Iron and Steel, Lighting, Non-ferrous Metals, Parts and Fittings, Passenger-car Body, Screw Threads, Springs and Stationary Engines. Special sessions were devoted to research, passenger cars, fuels and engines, aeronautics and motor buses. Mechanical problems were considered in papers by G. E. A. Hallett on Methods of Developing Aircraft Engines; by P. M. Held on Overhead Camshaft Passenger-Car Engines; and by H. M. Crane on A New System of Spring Suspension for Automotive Vehicles.

Considerable interest was aroused by a message from Secretary of Commerce Hoover offering the aid of his Division of Simplified Practice to the S. A. E. in securing the adoption of their standards. The message was presented by R. M. Hudson, of the Division. The report of the research director of the Society, Dr. H. C. Dickinson, was another of the interesting features of the meeting.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS

The thirty-eighth annual convention of the American Institute of Electrical Engineers was held at Niagara Falls June 26–30. The opportunity to visit and inspect the vast industrial developments which are operated by the power of Niagara Falls proved a lure to electrical engineers, and the attendance recorded, 950, was far in excess of expectations.

The address of welcome was delivered by A. Munro Grier, president of the Canadian Niagara Power Co., at the opening general session. A. P. M. Fleming addressed the Convention, representing the Institute of Electrical Engineers of Great Britain and the British National Committee of the International Electrotechnical Commission and the British Electrical Standards Association.

More than thirty technical papers, dealing with many phases of electrical engineering, were presented at the sessions, and discussion of these papers proved a valuable part of the Convention. Tuesday afternoon was devoted to a series of papers on the Queenston hydroelectric plant. Wednesday afternoon, set aside for a visit to the plant which contains the largest hydroelectric units ever built, was one of the high spots of the week. On Thursday morning a group of eight papers relating to cable insulation were presented, and Thursday evening was given over to a symposium on engineering education.

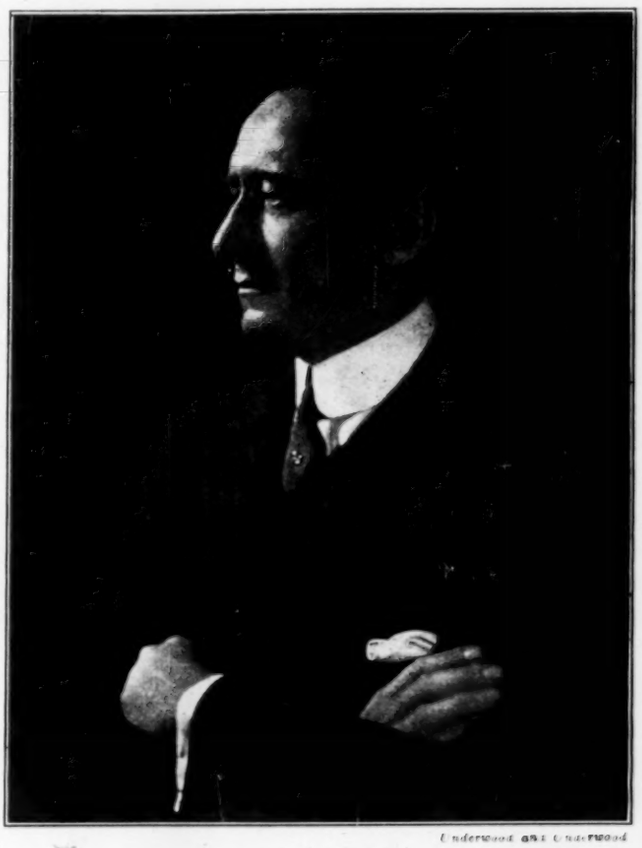
The officers of the Institute for next year are: President, F. B. Jewett of New York; Vice-Presidents, G. Faccioli, of Pittsfield, Mass., Prof. W. I. Slichter, of Columbia University, R. F. Schuchardt, of Chicago, H. W. Eales, of St. Louis, and H. T. Plumb of Salt Lake City; Managers, H. M. Hobart, of Schenectady, N. Y., Ernest Lunn of Chicago and G. L. Knight of Brooklyn. George A. Hamilton of Elizabeth, N. J., was reëlected Treasurer and F. L. Hutchinson of New York, Secretary.

John Fritz Medal for 1922 Awarded Senator Marconi

Wireless Inventor Receives Signal Honor before Distinguished Audience

BEFORE the largest gathering ever assembled on a similar occasion, the John Fritz Medal was presented to Senator Guglielmo Marconi on Thursday evening, July 6, at the Engineering Societies Building in New York City. The presentation of this Medal for 1922 attracted the interest of press and public in this and other countries, and the decision of the John Fritz Medal Board of Award in singling out the great Italian as medallist for his invention of wireless telegraphy has met with popular approval. The occasion of the formal conferring of the Medal was convincing evidence of the significance and influence of engineering in international affairs.

Previous to the presentation ceremonies, Senator Marconi was the guest of the Board of Award at a dinner at the Engineers' Club. Arrangements for the meeting were made by Prof. Comfort A. Adams of Harvard University, and Charles F. Rand of New York, chairman and secretary, respectively, of the John Fritz Medal Board of Award. Professor Adams presided at the meeting and read messages from other medallists, distinguished engineers and public men of America and Europe. The speakers included James R. Sheffield, prominent New York lawyer and president of the Union League Club; Michael I. Pupin, professor of electromechanics at Columbia University and famous for his inventions in the wireless art; and Elihu Thomson, former medallist, who presented the Medal to Marconi.



Underwood and Underwood

SENATOR GUGLIELMO MARCONI

Accepting the Medal, Senator Marconi said:

"I am extremely grateful for the very kind and flattering remarks which have been made in regard to myself and my work by the distinguished gentlemen who have been good enough to speak here tonight. It is indeed a great distinction and encouragement to further efforts, being received as I am, I may say, invariably received in this great country, and to meet here amongst my friends those who represent the best intellect in science and applied science as exemplified in the persons composing the great national engineering societies of America.

"I have long realized that in America more than anywhere else the most cordial and generous encouragement is given to any honest endeavor to apply science to useful and practical purposes.

"I consider myself fortunate that much of my early work in radio has been carried out in this country, for I cannot help feeling that you realize that wireless communication has become useful and often necessary on sea and on land, besides tending to increase and simplify the facilities for closer communications between distant peoples on this earth, thus contributing, I hope, to make goodwill take the place of the unrest and mutual suspicion which unfortunately seems at present to be a dominating feeling amongst the nations.

"It is a great honor for me to be admitted, through your award, to the ranks of the eminent men upon whom the John Fritz Medal has been bestowed. I beg to express my very high appreciation of this honor, and to offer my most grateful thanks for the distinction thus conferred upon me."

Senator Marconi is the nineteenth recipient of the John Fritz Medal. The award was established in 1902 as a memorial to the great engineer and metallurgist whose name it bears, and is presented for notable achievement in applied science. The Medal Fund was contributed by friends of Mr. Fritz and its administration was assigned to the Four National Engineering Societies.

The first award of the Medal was made to John Fritz on his eightieth birthday in 1902. Since that time eighteen awards have been made to men of the very highest distinction in the engineering profession. They include: Lord Kelvin, George Westinghouse, Alexander Graham Bell, Thomas A. Edison, Charles T. Porter, Alfred Noble, Sir William Henry White, Robert W. Hunt, John Edison Sweet, James Douglas, Elihu Thomson, Henry M. Howe, J. Waldo Smith, George W. Goethals, Orville Wright, Sir Robert A. Hadfield, Charles Prosper Eugene Schneider, and Guglielmo Marconi.

Four of the former medallists were present at the ceremonies in honor of Marconi. They were Dr. Elihu Thomson, prolific inventor in the field of applied electricity, Dr. J. Waldo Smith, who solved the problem of supplying New York City with water, Gen. George W. Goethals, builder of the Panama Canal, and Dr. Orville Wright, who with his brother Wilbur developed the first successful aeroplane. Attention was called to the presence of these four distinguished guests by the Chairman, and they were loudly acclaimed by the audience.

Professor Adams read messages of regret from Vice-president Coolidge, Herbert Hoover, Thomas Edison, Guido Sabetta, Charge d'Affairs of Italy at Washington, Sir Robert Hadfield of London, and Eugene Schneider of Paris.

The speakers of the evening dwelt upon different aspects of Marconi's life work and its meaning to human society. Mr. Sheffield pictured the personal side of the inventor, outlining his early life, his struggles and his ultimate triumph. He declared, "What Galileo was to his age, what Newton was to the law of gravitation, what Morse was to the telegraph, Bell to the telephone and Westinghouse to the airbrake, Marconi has been and is to the development of the wireless. His name will ever be linked to this most elusive, most fascinating and most marvelous of all modern achievements—the science and the art of miraculous radio."

Professor Pupin said: "No poet or philosopher of today would be sufficiently daring to predict with any degree of accuracy the future expansion of this new science. Preparations are now being made to transmit articulate speech from the new world to the old; these preparations will end in a great success, I am sure, and after this success who will deny the possibility that before many years have passed the word spoken in this great engineering hall will be heard in every other engineering hall on the face of the globe?....This will be the growth from the seed which Senator Marconi dropped into a fertile field."

The meeting was regarded among engineers as a forward step in developing and promoting closer relations between Italy and America and advancing the general idea of a world engineering union.

Proposed Standard for Malleable-Iron Screwed Fittings

Historical

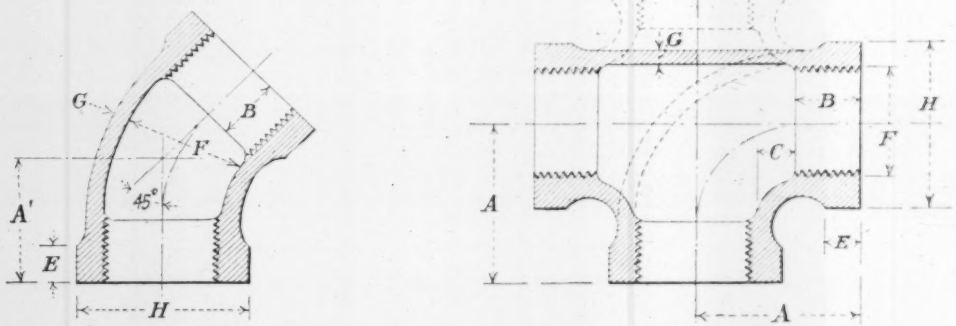
THE Sectional Committee on the Standardization of Pipe Flanges and Fittings, which is sponsored by the Committee of Manufacturers on Standardization of Fittings and Valves, the Heating & Piping Contractors National Association, and The American Society of Mechanical Engineers, has completed the preliminary report reproduced below and desires now to submit it to Industry for general review and criticism.

At the beginning of the committee's investigation a good deal of effort was directed toward the setting up of a standard for 150-lb.

DIMENSIONS OF STRAIGHT FITTINGS (INCHES)

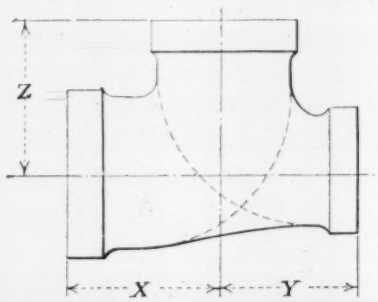
	SIZE	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6	7	8
A	CENTER TO END - ELLS, TEES & CROSSES	0.69	0.81	0.95	1.12	1.31	1.50	1.75	1.94	2.25	2.70	3.08	3.42	3.79	4.13	4.50	5.13		
A'	CENTER TO END - 45 DEG. ELLS	0.68	0.73	0.80	0.88	0.98	1.12	1.29	1.43	1.68	1.95	2.17	2.39	2.61	2.83	3.05	3.46		
B	LENGTH OF THREAD - MINIMUM	0.25	0.32	0.36	0.43	0.50	0.58	0.67	0.70	0.75	0.92	0.98	1.03	1.08	1.13	1.18	1.28	1.43	1.47
C	TAP CLEARANCES ELLS, TEES & CROSSES	0.237	0.220	0.252	0.270	0.285	0.262	0.250	0.290	0.322	0.340	0.350	0.390	0.460	0.500	0.539	0.539		
D	O. D. OF PIPE / 2	0.225	0.270	0.338	0.420	0.525	0.658	0.830	0.950	1.186	1.437	1.750	2.000	2.250	2.500	2.781	3.312	3.812	4.312
E	WIDTH OF BAND - MINIMUM	0.200	0.215	0.230	0.249	0.273	0.302	0.341	0.368	0.422	0.478	0.549	0.604	0.661	0.717	0.780	0.900	1.012	1.125
F	INSIDE DIAMETER MINIMUM	0.405	0.540	0.675	0.840	1.05	1.315	1.660	1.900	2.375	2.875	3.500	4.000	4.500	5.000	5.563	6.625	7.625	8.625
	INSIDE DIAMETER MAXIMUM*	0.435	0.584	0.719	0.897	1.107	1.385	1.730	1.970	2.445	2.975	3.600	4.100	4.600	5.10	5.663	6.725	7.725	8.725
G	THICKNESS - MINIMUM	0.090	0.095	0.100	0.105	0.120	0.134	0.145	0.155	0.173	0.210	0.231	0.248	0.265	0.281	0.300	0.336	0.370	0.403
H	OUTSIDE DIAM. OF BAND - MINIMUM	0.693	0.844	1.015	1.197	1.458	1.771	2.153	2.427	2.963	3.589	4.285	4.843	5.401	5.955	6.583	7.767	8.883	9.995

* MAXIMUM DIAMETER EQUALS OUTSIDE DIAMETER OF PIPE PLUS ONE DEPTH OF THREAD



CENTER TO END DIMENSIONS OF REDUCING FITTINGS (INCHES)

READ "END" OUTLET / READ "CENTER" OUTLET	1/8	1/4	3/8	1/2	3/4	1	1 1/4	1 1/2	2	2 1/2	3	3 1/2	4	4 1/2	5	6
1/8	0.69	0.76	0.85	0.93	1.03	1.17	1.34	1.47	1.69	2.04	2.33	2.58	2.85	3.19	3.47	4.00
1/4	0.74	0.81	0.90	0.98	1.08	1.22	1.39	1.52	1.74	2.09	2.38	2.63	2.90	3.24	3.52	4.05
3/8	0.81	0.88	0.95	1.03	1.13	1.27	1.44	1.57	1.79	2.14	2.43	2.68	2.95	3.29	3.57	4.10
1/2	0.90	0.97	1.04	1.12	1.22	1.36	1.53	1.66	1.88	2.23	2.52	2.77	3.04	3.38	3.66	4.19
3/4	0.98	1.05	1.12	1.20	1.31	1.45	1.62	1.75	1.97	2.32	2.61	2.86	3.13	3.47	3.75	4.28
1	1.04	1.11	1.18	1.26	1.37	1.50	1.67	1.80	2.02	2.37	2.66	2.91	3.18	3.52	3.80	4.33
1 1/4	1.12	1.19	1.26	1.34	1.45	1.58	1.75	1.88	2.10	2.45	2.74	2.99	3.26	3.60	3.88	4.41
1 1/2	1.19	1.26	1.33	1.41	1.52	1.65	1.82	1.94	2.16	2.51	2.80	3.05	3.32	3.66	3.94	4.47
2	1.27	1.34	1.41	1.49	1.60	1.73	1.90	2.02	2.25	2.60	2.89	3.14	3.41	3.75	4.03	4.56
2 1/2	1.41	1.48	1.55	1.63	1.74	1.87	2.04	2.16	2.39	2.70	2.99	3.24	3.51	3.85	4.13	4.66
3	1.54	1.61	1.68	1.76	1.87	2.00	2.17	2.29	2.52	2.83	3.08	3.33	3.60	3.94	4.22	4.75
3 1/2	1.64	1.71	1.78	1.86	1.97	2.10	2.27	2.39	2.62	2.93	3.18	3.42	3.69	4.03	4.31	4.84
4	1.76	1.83	1.90	1.98	2.09	2.22	2.39	2.51	2.74	3.05	3.30	3.54	3.79	4.13	4.41	4.94
4 1/2	1.82	1.89	1.96	2.07	2.18	2.31	2.48	2.60	2.83	3.14	3.39	3.63	3.88	4.13	4.41	4.94
5	1.94	2.01	2.08	2.19	2.30	2.43	2.60	2.72	2.95	3.26	3.51	3.75	4.00	4.25	4.50	5.03
6	2.10	2.17	2.24	2.32	2.43	2.56	2.73	2.85	3.08	3.39	3.64	3.88	4.13	4.38	4.63	5.13



PROPOSED AMERICAN STANDARD FOR CROSSES, TEES, 90 DEG. AND 45 DEG. ELLS, BOTH STRAIGHT AND REDUCING, FOR 150-LB. WORKING-STEAM PRESSURE

Note: To illustrate the use of the Table for Reducing Fittings, let it be assumed that the Center to End Dimensions of a 6 x 4 x 5 Tee are required: Then for X dimension read opposite 6 and under 5 = 4.63 in. Then for Y dimension read opposite 4 and under 5 = 4.41 in. For Z* dimension read opposite 5 and under 6 = 5.03 in. Dimension Z is determined by using largest run opening.

malleable screwed fittings, in which each dimension should bear a definite relation either to the outside diameter of pipe, or to the American Standard Pipe thread elements, or to a combination of both. This scheme as contemplated would produce a fitting shorter and lighter than a majority of those in common use. Considerable progress was made along this line of effort, and no doubt a satisfactory line of fittings might have been arrived at in this way. Fittings so designed, however, would not "line up," some sizes being considerably shorter than customarily made. It was, therefore, feared that they would be criticised by consumers and would be objectionable from the manufacturers' standpoint in that they could only be tapped with the American thread.

For these reasons it became the unanimous opinion of the members of the committee that the standard fitting should not depart greatly from those in common use and should be of such dimensions that the castings could be tapped with either American threads or with other commonly used pipe threads (British) without change in cores and without interference of tools.

DESCRIPTIVE

The above schedule of dimensions fulfills these requirements. Fittings made to this schedule will have dimensions equal to or greater than the minimum dimensions contained in the British Engineering Standards Association Report C. A. (M) 1637, and will have the following outstanding features:

1 Can be tapped either British or American Standard pipe thread both as to gage and length of threads in all sizes except the $2^1/_2$-in. which can be tapped American Standard pipe thread only, British $2^1/_2$-in. pipe being 3-in. O. D. whereas American pipe is only 2.875 in. O. D.

2 In casting the cores can be made from the same coreboxes for both malleable- and cast-iron fittings thus reducing the investment necessary for the production of a line of malleable- and cast-iron fittings.

3 Will not depart materially from dimensions of fittings already produced by some manufacturers which have demonstrated excellent appearance and serviceability

4 Can be varied in thickness of wall and size of bead, from the minimum which is considered the lightest advisable for the service for which they are recommended to any weight found necessary by any manufacturer, as the exigencies of his foundry and shop practice may require and still conform to the standard.

Engineering and Industrial Standardization

Safety Code for Conveyors and Conveying Machinery under Way

AN important step toward the solution of an accident problem has just been accomplished through the decision of the American Engineering Standards Committee that the development of a Safety Code for Conveyors and Conveying Machinery be undertaken.

The introduction of mechanical conveyors in many industries has eliminated a large proportion of the accidents resulting from the manual handling of materials, but it has at the same time introduced new hazards, many of which can be prevented by a more general agreement among both users and manufacturers of conveying equipment as to safe practices in the manufacture, installation, and operation of such equipment.

The American Society of Mechanical Engineers and the National Bureau of Casualty and Surety Underwriters have been appointed joint sponsors for this code. All interested national organizations will be asked to coöperate in the formulation of the code. This code, the American Engineering Standards Committee announces, will be intended as a guide for the safe operation and maintenance of conveyors and conveying machinery coming under the following main divisions: gravity, belt, chain, flight bucket, apron, screw and jigging conveyors, car hauls, aerial cableways, overhead trolley, and pneumatic tubes.

All shafting, pulleys, belts, link belts, chains, gears, sprockets, couplings, clutches, etc., used on and in connection with conveyors and conveying machinery will be covered in the Mechanical Power Transmission Code now in preparation.

Big Standardization Program Proposed for Electric Railway Field

A standardization program of considerable importance to the iron and steel, lumber, electrical, construction, chemical, railway and railway-supply industries is presented in the submission by the American Electric Railway Association of 13 standards for approval by the American Engineering Standards Committee.

The specifications submitted to the A.E.S.C. follow:

FOR APPROVAL AS AMERICAN STANDARDS

9-in. Girder Grooved Rail
7-in. Girder Grooved Rail
9-in. Girder Guard Rail
7-in. Girder Guard Rail
Joint Plates for 7-in. Girder Grooved and Girder Guard Rails
Joint Plates for 9-in. Girder Grooved and Girder Guard Rails
Specification for Galvanizing or Sheradizing on Iron and Steel

FOR APPROVAL AS TENTATIVE AMERICAN STANDARDS

7-in. 80-lb. Plain Girder Rail
7-in. 91-lb. Plain Girder Rail

FOR APPROVAL AS RECOMMENDED AMERICAN PRACTICE

Specification for Materials for use in the Manufacture of Special Track Work
Specification for 600-Volt Direct-Current Overhead-Trolley Construction.

Four special committees will be appointed by the American Engineering Standards Committee to determine whether the A.E.R.A. specifications are the standards which should be adopted for universal use in the United States; the Committee's decision will, of course, be predicated on its finding as to the desirability of national standardization of the products enumerated. The principal organizations concerned will be asked to name representatives on these special committees.

One special committee will be asked to conduct the investigation with respect to the acceptability to the industry of the specification for 600-volt direct-current overhead-trolley construction; another committee will conduct the investigation concerning the specifications for wood poles and tubular poles; a separate committee will study the specifications for galvanizing or sherardizing on iron and steel; and a fourth committee will go into the subjects of the remaining nine related specifications. The findings of these committees will be reported to the American Engineering Standards Committee as soon as the investigations are completed.

Meanwhile, the American Engineering Standards Committee requests the technical press, industrial associations, and technical bodies interested in these specifications to send to its headquarters at 29 West 39th Street, New York City, any available information as to the extent to which these specifications are meeting the needs of the industries concerned.

In submitting these standards, J. W. Welsh, executive secretary of A.E.R.A. wrote to the American Engineering Standards Committee as follows: "The committees in which the various specifications were prepared have been composed of men chosen for known experience and ability, and include electric-railway operating and construction engineers, producers and consulting engineers."

Colors for Traffic Signals to be Standardized

The day is not far off when red, green and yellow, when used as traffic signals, will each have its distinctive meaning and this meaning will be uniform all over the country, according to the decisions reached at the first fully representative conference ever held on the subject in this country. When that day arrives the annual toll of deaths and serious injuries resulting from traffic

accidents will be reduced by the elimination of accidents caused by the confusion or misunderstanding of signals.

This conference on the standardization of colors for traffic signals was recently held in New York under the auspices of the American Engineering Standards Committee. There were present representatives of practically all of the big national engineering societies, safety associations, electric- and steam-railway interests, automobile dealers, manufacturers' and users' associations, police and traffic departments, insurance companies, and several departments of the federal government.

The conference agreed unanimously "that there should be national uniformity in the use of colors for signals" and that the detailed technical work involved in bringing about such uniformity should be carried out by a thoroughly representative sectional committee under the auspices and procedure of the American Engineering Standards Committee. Included in the scope of the work as defined were the following:

The use of colored lights on all highway vehicles
Their use on all signals along highways and at curbs, both permanent and temporary
Their use for highway-crossing signals or steam and electric railways
A coördinated relation of color, form, position and number of signals
A coördinated relation to systems of flashing, moving or other similar lights
Colors for non-luminous as distinguished from luminous signals
Recommendations on the use of colors for emergency exit signals
Methods of specifying or defining colors for signals purposes
Any other closely related matters which, in the opinion of the sectional committee, form a part of the subject to be considered

Mr. A. H. Rudd, on behalf of the American Railway Association, presented a paper in which were summarized the general facts of the situation affecting the steam railroads, and suggested lines along which they would like to see standardization progress. While signal systems of different railroads differ in some respects, fundamentals are largely standardized. For the operation of trains these include: red for danger (stop); yellow for caution; and green for clear.

A paper by Mr. H. B. Flowers gave the experience of the American Electric Railway Association. The standard use for signals in electric-railroad practice is: red for stop; yellow for proceed with caution; and green for proceed at schedule speed. Blue, purple and white are also used in a restricted way, for conveying special information or for safe-guarding special conditions.

A suggestion that yellow light be used in place of red for the tail light of automobiles brought forth spirited discussion during which Mr. Alden L. McMurtry of the Department of Vehicles of Connecticut said: "It is very easy to place the entire responsibility for automobile accidents on the automobile driver while, as a matter of fact, the responsibility for conditions which exist rest not merely on the motorist, but also on the pedestrian and upon the steam and electric railways.

"Pedestrians often cause automobile accidents by ignoring traffic rules. Watchmen are not always at grade crossings when the signs say they should be there; and grade-crossing gates are, at times, down for considerable periods when trains are not going through. National uniformity in colors for traffic signals is extremely desirable, but if major changes are to be made, as for example, a change in the color of tail lights for automobiles, it would take at least two years to get such changes into operation because legislation would be required in most states."

On the motion of Dr. M. G. Lloyd of the U. S. Bureau of Standards, a resolution was adopted declaring it to be the sense of the conference that any sectional committee of the A.E.S.C. which takes up the standardization of colors for signals should endeavor to coördinate such standardization with existing standards for traffic purposes, such as those used in water and aerial navigation and on steam and electric railways.

The conference did not advocate the substitution of green for red as a danger signal, as was erroneously reported in certain of the daily papers through a misinterpretation of discussion at the conference. On the contrary, the ideas expressed at the conference were emphatically that red should be used to indicate danger and for no other purpose. In conformity therewith, it was suggested that green be substituted for red as the color for lights for emergency exits of public buildings as indicating paths that lead to safety.

No final technical decisions were reached at the conference, these being left to be worked out in detail by a thoroughly representative sectional committee.

C. Russ Richards Welcomed at Lehigh University

C. Russ Richards, Mem. Am.Soc.M.E., president-elect of Lehigh University, was given a "welcome dinner" by the alumni of that institution in the University Commons on Friday evening June 9. Dr. Richards was introduced to this new constituency by William C. Dickerman, Mem. Am.Soc.M.E., an alumni member of Lehigh's Board of Trustees. In a felicitous address Mr. Dickerman described the two-years' successful search for a man who could unite faculty, alumni, student body and trustees. Dr. Richards was given a great "hand" when he rose to respond. He modestly stated that he had not had time nor opportunity to formulate any hard-and-fast policy or plan. He intimated that any reorganization would grow up out of conferences and after a painstaking ascertainment of the existing situation.

Dr. Richards excited the sympathy of all present by referring to Seth Low's definition of a college president as one "who gives and receives pain." He then sketched out in frank fashion his own faith as to the essentials of a technical education, especially as to the importance of thoroughness and the personal touch between student and teacher. He said that he did not want an enrollment in Lehigh much above what it was, 1,000, but would rather have it an outstanding institution of its class in which a breadth of knowledge and an understanding of men would be given recognition alongside of the more technical studies. He protested against undue specialization at the expense of breadth of education and pleaded for a study of the problems of life and of men. He believed that engineers should stand between labor on the one hand and the employer on the other and that there is less importance in what we teach than in how we teach it. After expressing the hope that the library could be much enlarged and saying that he intended to stress research he closed with an eloquent appeal for educational experiments, neither radical nor revolutionary, in order to develop a system which would train for leadership.

Dr. Richards will be the sixth president of Lehigh University, Drs. Copper, Leavitt, Lamberton, Drown and Drinker preceding him. He is the second engineer in the line. Dr. Drown was a mining engineer, Dr. Leavitt a minister, Drs. Copper and Lamberton learned in belles lettres, while Dr. Drinker was a lawyer. Dr. Richards will finish out the present academic year as Dean of the School of Engineering at the University of Illinois, and take up his new duties in South Bethlehem on September 1.—M. L. C.

Dr. W. H. Maw Elected President, Institution of Civil Engineers

Dr. William Henry Maw, Past-President of the Institution of Mechanical Engineers, Past-President of the Royal Astronomical Society, Fellow of the Royal Geographical Society, and member of the A.S.M.E., has been elected President of the Institution of Civil Engineers of Great Britain.

Dr. Maw has been a joint editor of London *Engineering* since 1866, and it is largely due to his editorial policies through over half a century that this paper has received world wide recognition as a leader in the field of engineering journalism.

Dr. Maw received his early engineering training as a railroad engineer in the Works of the Great Eastern Railway. He served notably in the War, being a member of the Advisory Panel of the Munitions Inventions Department in the British Ministry of Munitions. He is the author of several books on engineering subjects, including railroad and marine engineering, and of astronomical papers. He was a member of the Royal Commission for the St. Louis Exposition in 1904. Dr. Maw is a veteran engineer. He was born in 1838, and has been a member of the A.S.M.E. since 1913.

LIBRARY NOTES AND BOOK REVIEWS

L'Azote. By Louis Hackspill. Masson et Cie; Gauthier Villars et Cie, Paris, 1922. (Encyclopédie Léauté.) Paper, 5×8 in., 271 pp., illus. 14 fr.

As a member of military commissions of chemical control in Germany, the author acquired an intimate knowledge of the nitrogen industry and had an opportunity to study thoroughly the commercial plants at first hand. His book deals with the different processes, giving the history of each and describing the reactions and apparatus used. The various processes are also compared critically from the economic point of view.

Building Contracts. By Edwin J. Evans. E. P. Dutton & Co., New York, 1922. (Directly useful technical series.) Cloth, 6×9 in., 304 pp. $5.

A book on business management for contractors, dealing with the various matters that chiefly affect the administration of a contractor's business, and giving suggestions as to the best means of mobilizing and organizing the available forces for the financial and constructional success of the work. Adapted to conditions and practices of the building trade in England, but may be suggestive in this country.

Coal. By Elwood S. Moore. John Wiley & Sons, Inc., New York, 1922. Cloth, 6×9 in., 462 pp., illus., maps, tables, $5.

Prepared to satisfy the demand for a convenient modern summary of the voluminous scattered literature on coal. Covers quite fully such topics as the properties, origin, uses and general distribution of coal, while discussing only in a more general way such subjects as mining machinery and the details of distribution and character of local deposits.

Dynamics of the Aeroplane. By René Devillers. Translated by W. J. Walker. New impression. Lond., E. & F. N. Spon., Ltd., London, 1922. Cloth, 6×9 in., 302 pp., 15s.

The author's investigation is concerned with the effects upon the equilibrium of an airplane of the movement of its center of gravity and that about its center of gravity; or in other words of the different paths of flight and of its stability. The theoretical considerations are considered and the mathematical formulas evolved, but the principal aim has been to condense experimental results into simple technical form which the engineer can put to immediate use. All current formulas have been reduced to nomographic form, the book being, according to the translator, the first in English to adopt that method throughout.

Electric-Power Systems. By William T. Taylor. Sir Isaac Pitman & Sons, Ltd., London and New York, 1922. (Pitman's technical primer series.) Cloth, 4 × 6 in., 107 pp., $0.85.

This little book is an extremely brief introductory statement of the main technical facts and principles governing modern practice in the larger electric power systems. General circuit conditions are considered; the most important methods and problems in generation, transmission and distribution practice are explained; and special attention is paid to system operation, to the various "system factors" used, and to the importance of keeping reliable operating records.

Essai D'Optique sur la Gradation de la Lumiere. By Pierre Bouguer. Gauthier-Villars et Cie, Paris, 1921. (Les maitres de la pensée scientifique.) Paper, 5×7 in., 129 pp., 3fr.

This classic of the literature of optics is an account of Bouguer's study of certain important optical problems connected with the radiation of light and its absorption by various substances. It is the work which first set forth the basis of photometry, and led to the invention of the photometer by the author in 1748. The present edition reproduces the original text of 1729.

Industrial Fatigue and Efficiency. By H. M. Vernon. E. P. Dutton & Co., New York, 1921. Cloth, 6×9 in., 264 pp., tables, $5.

The author, who is an investigator for the Industrial Fatigue Research Board of Great Britain, presents a fairly complete account of our present knowledge concerning industrial fatigue and its influence on efficiency. The information adduced relates only to shop practice, as laboratory investigations have not, in the author's opinion, afforded much evidence of practical value.

Introduction to Electrodynamics. By Leigh Page. Ginn & Co. Boston and New York, 1922. Cloth, 6×8 in., 134 pp., $2.

The object of this book is to present a logical development of electromagnetic theory founded upon the principle of relativity. So far as the author is aware, the universal procedure has been to base the electrodynamic equations on the experiments of Coulomb, Ampére and Faraday, even books on the principle of relativity going no farther than to show that these equations are covariant for the Lorentz-Einstein transformation. As the dependence of electromagnetism on the relativity principle is more intimate than this covariance suggests, he believes it more logical to derive the electromagnetic equations directly from this principle. The book covers topics appropriate for a one-year graduate course in electrodynamics and electromagnetic theory of light. It should interest those who are looking for a logical rather than a historical account of the science.

General Economic Geology. By William Harvey Emmons. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 516 pp., illus., $4.

This volume is an introduction to the study of mineral deposits, for use by students with a knowledge of the elements of general geology and mineralogy. It embraces the geology of mineral fuels, structural materials and other non-metals, and of the metals. The first chapter includes introductory matter, definitions and an outline of the classification of mineral deposits. It is followed by a treatment of coal, petroleum and the solid bitumens. Then follows a more detailed discussion of the classification and genesis of mineral deposits, which is succeeded by sections on non-metals and metals. Numerous footnotes call attention to the principal sources of information on each topic.

La Matiere et l'Energie Selon la Theorie de la Relativite et la Theorie des Quanta. By Louis Rougier. New edition, revised and enlarged. Gauthier-Villars & Co., Paris, 1921. Paper, 7×10 in., 112 pp., 9.50 francs.

This book calls attention to the most paradoxical and least discussed consequence of the principle of relativity, that which attributes mass, weight and structure to energy. What we call matter thus becomes only a particular case of energy. The old duality of ponderable and imponderable makes way for that of the electro-magnetic field or *energy*, of which radiation and matter are simple modalities, and of the field of gravitation of *space* as defined by Einstein. Professor Rougier presents these theories in this work.

Metal Cutting Tools. By A. L. De Leeuw. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 328 pp., illus., diagrams, $3.

The book is intended to bring before the reader the principles that must be applied in selecting, designing, maintaining and, especially, in using metal-cutting tools. It is intended for engineers, foremen, time-setters and mechanics. But slight use is made of mathematics, and mathematical knowledge is not essential for an understanding of most subjects considered.

Maschinenuntersuchungen und das Verhalten der Maschinen im Betriebe. By A. Gramberg. Second edition, revised and enlarged. J. Springer, Berlin, 1921. Cloth, 6×9 in., 681 pp., illus.

Volume two of the author's treatise on methods for testing machines, the first volume of which is devoted to measuring apparatus. This volume discusses methods of testing and the behavior of machines while running. The subjects treated include boiler tests, fuel tests, heat conductivity, steam turbines and reciprocating

engines, exhaust steam utilization, internal combustion engines, pumping machinery, blowers, air compressors and refrigerating machines. A section is devoted to regulation and governing. An introductory section discusses the economic and legal aspects of tests. The work is intended to assist in the selection of proper tests, to describe correct tests and to indicate how the results of costly tests can be fully analyzed.

MECHANICAL STOKERS. By Joseph G. Worker and Thomas A. Peebles First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth 6×9 in., 258 pp., illus., tables, diagrams, $3.

Although stokers are treated in books on boilers and power-plant equipment, there has been no work treating the stokers as a separate unit until the appearance of the present volume. It treats the phenomena of combustion in relation to stokers, describes mechanical stokers and modern practice in stoker installation and use, and discusses the selection of stokers for different fuels and differing conditions. The authors have endeavored to give reliable unbiased opinions and facts from field experience in design, installation and operation.

MODERN GAS TRACTOR. By Victor W. Page. Fourth edition, revised and enlarged. The Norman W. Henley Publishing Co., New York, 1922. Cloth, 5×7 in., 590 pp., illus., diagrams, $3.

The object of the author has been to present the principles of design in a simple manner and to show how these principles have been followed in various types of construction, so that the advantages of the various methods may be intelligently analyzed by the average farmer and mechanic. The book is intended to assist in the selection of the best mechanism for individual requirements. Chapters on maintenance and repair are included.

NOTES ECONOMIQUES D'UN METALLURGISTE. By Camille Cavallier. Gauthier-Villars et Cie, Paris, 1921. Paper, 6×9 in., 153 pp., 3 fr. 50.

These brief economic discussions, by a French iron manufacturer, treat various present problems of French industry, particularly metallurgy. Such questions as the comparison between the foreign trade of France and Germany, the participation of manufacturers in national affairs and the relations of the heads of enterprises with capital and labor are treated, and the causes of and remedies for the present economic crisis are discussed in the light of long experience in industry.

ORGANIC CHEMISTRY. By Victor von Richter. Vol. II. Chemistry of the carbocyclic compounds. P. Blakiston's Son & Co., Philadelphia, 1922. Cloth, 6×9 in., 760 pp., $8.

After an interval of six years since the appearance of volume one, the second volume of this translation, dealing with the carbocyclic or closed carbon chain compounds, is now available. The translation follows the 11th German edition, prepared in 1912. The outstanding feature of this work is the large number of compounds listed, with outlines of the methods for preparing them and accounts of their important properties. No other book of its size gives such an exhaustive list. Because of this comprehensiveness, the book is most useful for reference, particularly when the large encyclopedias are not accessible.

PRINCIPLES OF ELECTRICAL ENGINEERING. By William H. Timbie and Vannevar Bush. John Wiley & Sons, Inc., New York, 1922. Cloth, 5×8 in., 513 pp., illus., $4.

This textbook, written for students of college grade, with a knowledge of calculus and physics, aims to provide a substantial first course in the subject which will present rigorously, yet in understandable form, the basic principles underlying modern electrical engineering, to be followed by detailed courses in direct and alternating current machinery. Special features are the stressing of the subject of the magnetic circuit; the use of the electron theory as a basis for explanation; the inclusion of the subjects of thermionic omission, conduction through gases, electrolytic conduction and high-frequency phenomena; a novel approach to the subject of the behavior of dielectrics and numerous live problems.

PRINCIPLES OF MECHANICAL REFRIGERATION. By H. J. Macintire. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×8 in., 252 pp., illus., diagrams, $2.50.

Based on a "study course" of twenty articles published in *Power* during 1920. The book is intended to cover the entire field of refrigeration in an elementary manner, with little use of mathematics. Analogies to steam machinery and steam cycles are used to explain the action of refrigeration.

STEAM POWER PLANT AUXILIARIES AND ACCESSORIES. Terrell Croft, editor. First edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×8 in., 447 pp., diagrams, illus., $3.

This book is intended to give data that will assist the power-plant engineer to select proper auxiliary equipment and install, operate and maintain it so that preventable losses will be kept as low as possible and power will be generated at the least cost. The subjects treated include pumps, boiler-feeding apparatus, feed-water heaters, economizers, condensers, cooling ponds and towers, steam piping, steam separators and steam traps. The treatment is simple, non-mathematical and descriptive.

STEEL FOUNDRY. By John Howe Hall. Second edition. McGraw-Hill Book Co., Inc., New York, 1922. Cloth, 6×9 in., 334 pp., illus., diagrams, tables, $4.

Mr. Hall's object has been to set forth the metallurgy of the steel foundry from the point of view of the engineer interested in prescribing the cheapest means of producing objects of sufficient excellence for the purposes for which they are intended. His book considers the classes of steel castings in demand today and their characteristics from a manufacturing point of view; the types of steel-making processes in use and the characteristics that govern the selection of one or another for making the sort of castings desired; and shop procedure in the light of its influence on quality and cost. The revision has introduced new data on electric-furnace practice, on molding sands, heat treatment and other phases of foundry practice.

THERMAL STRESSES IN CHILLED IRON CAR WHEELS. By G. K. Burgess and R. W. Woodward. Government Printing Office, Washington, 1922. (Technologic papers of the Bureau of Standards, No. 209. Paper, 7×10 in., 34 pp., plates, diagrams, $0.05.

Describes a method for testing car wheels under conditions nearly like those encountered in descending long grades, and gives the results obtained from a series of tests. Twenty-eight wheels of varying weight and design were tested, sixteen of which cracked in the plate. The tests suggest the possibility of improving the design of these wheels.

COMPOUNDING THE COMBUSTION ENGINE

(*Continued from page 527*)

he believes they will serve to mark a definite turning point in combustion-engine construction. Meanwhile he agrees with the discussion that it is to be regretted that he did not have the performance, say, the fuel consumption, of a larger than 7-in. cylinder to base reports on when the paper was written. Larger engines are, however, usually better than smaller engines and certainly much better than minute engines in this regard. The smallness of the 7-in. cylinder has been referred to several times, but let us examine the performance of this little engine. It has given 0.302 and 0.305 lb. of 16 to 22 Baumé fuel per indicated horsepower-hour in spite of the fact that it has all the imperfections of an experimental engine. This the author does not hesitate to submit as being a fairly good performance for this size of machine, being about the same as that recently reported on the *William Penn* engines with their ponderous 29 1/8-in. cylinders. Entirely unnecessary wire drawing exists at two points in this engine, which was found to rise to larger proportions than was expected and has been eliminated in later designs. Other than this, the mechanical losses in this engine are extremely low, as referred to in the paper.

To those who profess to see no virtue in compounding, it may be said that if the thermal units were being excessively absorbed by the chilled walls or are going astray in the many ways claimed by such critics, they most emphatically would never reach the indicator. This, the author feels, is a more complete answer to the various points raised than is sometimes realized.

THE ENGINEERING INDEX

(Registered United States, Great Britain and Canada.)

THE ENGINEERING INDEX presents each month, in conveniently classified form, items descriptive of the articles appearing in the current issues of the world's engineering and scientific press of particular interest to mechanical engineers. At the end of the year the monthly installments are combined along with items dealing with civil, electrical, mining and other branches of engineering, and published in book form, this annual volume having regularly appeared since 1906. In the preparation of the Index by the engineering staff of The American Society of Mechanical Engineers some 1200 technical publications received by the Engineering Societies Library (New York) are regularly reviewed, thus bringing the great resources of that library to the entire engineering profession.

Photoprint copies (white printing on a black background) of any of the articles listed in the Index may be obtained at a price of 25 cents a page. When ordering photoprints identify the article by quoting from the Index item: (1) Title of article; (2) Name of periodical in which it appeared; (3) Volume, number, and date of publication of periodical; (4) Page numbers. A remittance of 25 cents a page should accompany the order. Orders should be sent to the Engineering Societies Library, 29 West 39th Street, New York.

ACCIDENT PREVENTION

Mines. An Inventory of Results of Accident Prevention, C. A. Allen. Trans. Amer. Inst. Min. & Met. Engrs. issued with Min. & Metallurgy, May 1922, no. 1155 M, 9 pp., 8 figs. Facts and figures in effort to reduce fatalities in Utah.

ACETYLENE

Generating Plant. Acetylene Generator, Messer & Co. Type (Oberflur-Azetylenentwickler, Bauart Messer & Co.). Zeit. für komprimierte u. flüssige Gase, vol. 22, no. 2, 1922, pp. 17–21, 3 figs. Detailed description. Freedom from risk, automatic charging of carbide, its complete gasification.

AERONAUTICAL INSTRUMENTS

Operation Recorders. Showing An Aviator How He Flies. Aviation, vol. 12, no. 23, June 5, 1922, pp. 658, 659, 2 figs. Three special instruments developed by N.A.C.A. for accurately recording aviator's operations and performance of aeroplane in flight. See also Aerial Age, vol. 15, no. 11, May 22, 1922, p. 249.

AERONAUTICS

Aerial Laws and Safety Survey. Aerial Laws and Survey of Safety in Flight Urged by Aeronautical Chamber of Commerce. Aerial Age Weekly, vol. 15, no. 11, May 22, 1922, pp. 246–247. Report of Aeronautical Chamber of Commerce points out meager capital, insufficient terminal facilities, popular doubt as to reliability, and need of aerial code, as hindrances to development.

AIR COMPRESSORS

Foundry. The Compressor for Foundry Purposes. Compressed Air Mag., vol. 27, no. 6, June 1922, pp. 159–161, 5 figs. Lubricating system, method of regulation, air receiver and aftercooler have much influence upon operation of pneumatic devices.

AIR FILTERS

Visco. A New Form of Air Filter. Engineer, vol. 133, no. 3456, Mar. 24, 1922, pp. 339–340, 2 figs. Describes Visco air filter, in which filtering medium consists of an innumerable mass of short rings cut from very thin coppered steel tubing, coated with film of mineral oil termed Viscinol. See also Elec. Rev., vol. 90, no. 2321, May 19, 1922, p. 717.

AIR PUMPS

"Delas" Air Extractor. Tests of a "Delas" Air Extractor. Elec. Ry. & Tramway Jl., vol. 46, no. 1130, May 12, 1922, pp. 205, 207–208, 3 figs. Results of test on Delas air extractor, manufactured by Société Condenseurs Delas, with regard to its use in reducing steam consumption.

AIRCRAFT

Commercial. More Business at Less Cost Marks Commercial Aircraft Growth. Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1165–1173. Survey of operations in U. S. Practical utility definitely demonstrated. Expansion averages about 20 per cent.

Performance Testing. Performance Testing of Aircraft, T. M. Barlow. Aeronautical Jl., vol. 26, no. 137, May 1922, pp. 152–176, 21 figs. Outline of method carried out in England with special reference to routine at R.A.F. Aeroplane Experimental Establishment, Martlesham Heath.

Power Requirements of. Some Power Requirements of Aircraft, D. Roesch. Armour Engr., vol. 13, no. 4, May 1922, pp. 223–234, 7 figs. General discussion, with special reference to helicopter.

Radio Antennae. Radio Antennae of Aerial Vehicles (Sulle antenne radiotelegrafiche dei veicoli aerei), Algeri Marino. Elettrotecnica, vol. 9, no. 11, Apr. 15, 1922, pp. 242–247, 6 figs. Discusses differences from terrestrial antennae.

AIRPLANE ENGINES

Bavarian Motor Works 185-Hp. Performance of B.M.W. 185-Horsepower Airplane Engine, S. W. Sparrow. Nat. Advisory Committee for Aeronautics, Report no. 135, 1922, 10 pp., 22 figs. Deals with test made in altitude chamber of Bur. of Standards upon a Bavarian Motor Works engine, having six water-cooled cylinders with bore of 5.90 in., stroke of 7.09 in., and compression ratio of 6.7.

Bristol "Lucifer," 100 Hp. The 100 Hp. Bristol "Lucifer" Passes its Type-Tests. Flight, vol. 14, no. 19, May 11, 1922, pp. 267–268, 2 figs. Description of tests showing fine performance of this air-cooled engine.

Design. Aeronautical Engines, Their Evolution and Actual Tendencies (Les moteurs d'aviation, évolution, tendances actuelles), Martinot-Lagarde. Bul. de la Société d'Encouragement pour l'Industrie Nationale, vol. 134, no. 3, Mar. 1922, pp. 187–222, 23 figs. Commercial and military engines; characteristics of aeronautical engines, their mechanical construction, efficiency; engines for high altitudes; supercharging; etc.

Efficiency. Useful Work of High-Speed Explosion Engines (Het nuttig effect der moderne snelloopende explosiemotoren), I. Bauly. Ingenieur, vol. 37, no. 13, Apr. 1, 1922, pp. 244–257, 7 figs. Review of literature by engineer of Dutch Aeronautical Service, discussing useful mechanical work, useful thermic effect, fuels and combustion, heat balance of aero engines, etc.

Estimating Performance in Flight. Method for Estimating Power and Fuel Consumption of Normal Compression Aviation Engines in Flight at Various Altitudes. Air Service Information Circular, vol. 4, no. 317, Mar. 15, 1922, 6 pp. Object of report is to furnish standard method for estimating performance.

Starters, Buzzer. Fifty-Hour Endurance Flight Test of Auxiliary Starting Device (Buzzer Starter) for the Liberty Engine. Air Service Information Circular, vol. 4, no. 302, Feb. 15, 1922, 1 p., 1 fig. Results of test to determine durability of "buzzer" starter in actual flight service.

AIRPLANE PROPELLERS

Deformation During Flight. Determination of the Amount of Deformation of the Propeller Blades During Flight (Bestimmung der Deformationsgrösse von Schraubenblättern im Marsche). R. Katzmayr. Motorwagen, vol. 25, no. 12, Apr. 30, 1922, pp. 223–225, 4 figs. Discusses two methods, one by fixing an incandescent bulb at end of propeller blade, and other by using a source of light visible in proportion to number of revolutions.

AIRPLANES

Fuel Tanks, Safety. Safety Fuel Tanks for Aeroplanes. India-Rubber Jl., vol. 63, no. 18, May 6, 1922, pp. 17–19, 5 figs. Air Ministry prize of £1400, in official competition for petrol tanks used in aircraft won by I.R.G.P. Co. with an interesting rubber covered tank. Describes tests and the successful Silvertown tank. See also Aeroplane, vol. 22, no. 19, May 10, 1922, pp. 336 and 338.

Irwin "Meteorplane." The Irwin "Meteorplane." Aviation, vol. 12, no. 21, May 22, 1922, p. 599, 2 figs. Small single-seater tractor biplane designed to meet demand for small light-weight airplane of conventional design; 2-cylinder air-cooled engine; 15 hp. at 1900 r.p.m.

Static Test. Report of Static Test of Ski for an SE-5 Airplane. Air Service Information Circular, vol. 4, no. 322, Mar. 15, 1922, 1 p., 2 figs. Results of test conducted for purpose of determining structural strength of SE-5 ski. Description of ski.

Stress Analysis of JL-6. Study of Stress Analysis of the JL-6. Air Service Information Circular, vol. 4, no. 332, Mar. 15, 1922, 2 pp. Methods used in design of German airplane developed by Hugo Junker.

Tires and Wheels. Discussion of Airplane Tires and Wheels. Air Service Information Circular, vol. 4, no. 303, Feb. 15, 1922, 11 pp., 8 figs. Notes on wheel designs, rims, wheel lacing, hub attachment, tires, physical tests of wheels and of tires, designers' limitations, etc. Presents charts showing load deflection for airplane tires of standard sizes.

Vickers Commercial. The Vickers "Vulcan" Eight-Passenger Commercial Biplane. Flight, vol. 14, no. 18, May 4, 1922, pp. 253–254, 255–258, 22 figs. Description of plane nearing completion at Weibridge works, equipped with 360-hp. Rolls-Royce "Eagle VIII" engine.

Wing Spars. The Design of Wing Spar Sections, E. P. Warner. Aviation, vol. 12, no. 22, May 29, 1922, pp. 626–627, 2 figs. Develops formulas and gives curves.

AIRSHIPS

German. The German Airship (Das deutsche Luftschiff), Werner v. Langsdorff. Schiffbau, vol. 23, nos. 31 and 33, May 3 and 17, 1922, pp. 940–942 and 985–990, 10 figs. May 3: Detailed description of development and construction of Parseval type. May 17: Describes equipment in detail and gives list of Parseval ships from 1906–1916.

Semi-Rigid. Italian Semi-Rigid Airships (Il dirigible semirigido italiano), G. Arturo Crocco. Rivista Marittima, vol. 55, no. 3, Mar. 1922, pp. 901–927, 9 figs. Developments from France and Lebaudy types; horsepower and load; possibilities of aerial navigation.

ALLOYS

See ALUMINUM ALLOYS, COPPER ALLOYS, FERRONICKEL, MAGNESIUM ALLOYS, PHOSPHOR BRONZE.

ALUMINUM

Solders for. Investigation of Some Solders for Aluminum. Air Service Information Circular, vol. 3, no. 298, Feb. 15, 1922, 1 fig. Determination of effect of small additions of aluminum, copper, magnesium, on alloys of tin-zinc base used for aluminum soldering.

Uses. Aluminum and Its Utilization (Die Verwendungsgebiete des Aluminiums), J. Czochralski. Zeit. für Metallkunde, vol. 14, no. 1, Jan. 1922, pp. 1–7, 8 figs. Chemical and mechanical properties of aluminum and aluminum alloys and selection of alloys for particular purposes.

ALUMINUM ALLOYS

Aluminum-Silicon. New Aluminum-Silicon Alloys, R. E. Search. Metal Industry (N. Y.), vol. 20, no. 5, May 1922, pp. 183–185. Description of "Aladar," "Aludar" and "Silumin" all alloys of aluminum and silicon, and their origin.

Properties. Properties of Aluminum Alloys. Am. Mach., vol. 56, no. 22, June 1, 1922, pp. 805–806. Why these alloys make good castings; saving in cost shown in relative weights; advantages of melting

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NOTE.—The abbreviations used in indexing are as follows:

Academy (Acad.)
American (Am.)
Associated (Assoc.)
Association (Assn.)
Bulletin (Bul.)
Bureau (Bur.)
Canadian (Can.)
Chemical or Chemistry (Chem.)
Electrical or Electric (Elec.)
Electrician (Elecn.)
Engineer[s] (Engr.[s])
Engineering (Eng.)
Gazette (Gaz.)
General (Gen.)
Geological (Geol.)
Heating (Heat.)
Industrial (Indus.)
Institute (Inst.)
Institution (Instn.)
International (Int.)
Journal (Jl.)
London (Lond.)
Machinery (Machy.)
Machinist (Mach.)
Magazine (Mag.)
Marine (Mar.)
Materials (Matls.)
Mechanical (Mech.)
Metallurgical (Met.)
Mining (Min.)
Municipal (Mun.)
National (Nat.)
New England (N. E.)
Proceedings (Proc.)
Record (Rec.)
Refrigerating (Refrig.)
Review (Rev.)
Railway (Ry.)
Scientific or Science (Sci.)
Society (Soc.)
State names (Ill., Minn., etc.)
Supplement (Supp.)
Transactions (Trans.)
United States (U. S.)
Ventilating (Vent.)
Western (West.)

range, thermal conductivity, rigidity, and shrinkage.

AMMONIA

Pressure-Total Heat Diagram. The Pressure-Total Heat Diagram for Ammonia. H. J. Macintire and G. H. Bohn. Ice & Refrigeration, vol. 62, no. 5, May 1922, pp. 392–394, 2 figs. Simple graphical representation of properties of saturated and superheated ammonia, based upon Bur. of Standards and Goodenough-Mosher data, illustrating various refrigeration cycles, etc.

AMMONIA COMPRESSORS

Compound. Compound Ammonia Compression. G. A. Horne. A.S.R.E. Jl., vol. 8, no. 6, May 1922, pp. 455–487, 3 figs. Methods of intercooling. Cylinder ratios for compound ammonia compression. Horsepower curves.

Cylinder Design. Compressor Cylinder Design. J. H. H. Voss. Refrig. World, vol. 57, no. 5, May 1922, pp. 11–15, 11 figs. Importance of providing effective valve area in order to prevent waste of power through excess cylinder pressure. Table for calculating correct valve area.

Valves for High-Speed. Valves for High-Speed Ammonia Compressors. J. H. H. Voss. Power, vol. 55, no. 16, Apr. 18, 1922, pp. 619–621, 8 figs. Summarizes desirable points of construction that should be incorporated in design of every light plate valve if used on ammonia compressors.

ANEMOMETERS

Thermometric. The Thermometric Anemometer. J. S. G. Thomas. Lond., Edinburgh & Dublin Philosophical Mag., vol. 43, no. 256, Apr. 1922, pp. 688–698, 3 figs. Calibration curves of low-capacity anemometer of thermometric type for velocities of a few cm. per sec. and upward, and variations caused by heat losses due to conduction and radiation.

APPRENTICES, TRAINING OF

Systems. Trends in Management. William Leavitt Stoddard. Factory, vol. 28, no. 5, May 1922, pp. 528–529, 548 and 550, 2 figs. Deals with apprenticeship plan, and describes certain systems in the United States.

ARTILLERY

Cartridge Cases, Testing. Testing Artillery Cartridge Cases. J. Burns Read and S. Tour. Am. Inst. Min. & Met. Engrs. Trans., advance paper, no. 1151-N, Mar. 1922, 53 pp., 44 figs.; also (abstract) in Min. & Metallurgy, no. 184, Apr. 1922, pp. 33–35, 3 figs. Summary of metallurgical information and experience gained by Ordnance Dept. during war in manufacture of artillery cartridge cases. Describes tests to which artillery cartridge cases were put.

ASBESTOS

Fire Prevention. The Part Asbestos Plays in Fire Prevention. Maurice J. Hoover. Fire & Water Eng., vol. 71, no. 20, May 17, 1922, pp. 899–900, 905 and 920, 6 figs. Nature provides certain non-burnable materials which can be used for building purposes; advantages of asbestos for roof covering; importance of interior fireproofing.

ASH HANDLING

Plants. Pneumatic Ash Handling Plant (Pneumatische Entaschungsanlagen). Philippi. Archiv für Warmewirtschaft, vol. 3, no. 4, Apr. 1922, pp. 63–66, 9 figs. Details of construction of small and large plants and advantages of pneumatic conveying.

Sluicing and Pumping. Pumping Ashes. Eng. & Indus. Management, vol. 7, no. 15, June 1, 1922, pp. 481–482, 1 fig. Sluicing process for removal of ashes.

ATOMS

Isotopy. Recent Results of the Investigation of the Atom (Neuere Ergebnisse der Atomforschung). Karl Przibram. Elektrotechnik u. Maschinenbau, vol. 40, no. 18, Apr. 30, 1922, pp. 205–210, 2 figs. Discusses question of isotopy of certain elements which, in spite of different radioactive behavior and different atomic weights, show exactly same chemical properties.

AUTOGENOUS WELDING

Safety Device. A New Safety Device for Autogenous Welding (Eine neue Rückschlagsicherung als Ersatz für Wasservorlagen in Schweissereibetrieben). Theo Kautny. Autogene Metallbearbeitung, vol. 15, no. 7, Apr. 1, 1922, pp. 93–96, 2 figs. Describes device for preventing oxygen from entering acetylene supply pipe, which might lead to explosion.

AUTOMOBILE ENGINES

Boring Machines for Crankcase. Boring and Running-In Machine for Motor-Omnibus Crankcases. Engineering, vol. 113, no. 2941, May 12, 1922, pp. 586–588, 11 figs. Description of recently invented tool by which through four simultaneous operations three crankcases can be finished per hour.

Cams and Poppet Valves. Experiments on Cams and Poppet Valves. G. E. Scholes. Automobile Engr., vol. 12, no. 163, May 1922, pp. 151–157, 16 figs. Introduces formulas and charts. Paper read before Inst. Automobile Engrs.

Crankshafts, Machining. Machining a Case Hardened Mack Crankshaft. Fred H. Colvin. Am. Mach., vol. 56, no. 16, Apr. 20, 1922, pp. 585–587, 9 figs. Hard and long-wearing surfaces secured by case hardening. Straightening, turning and grinding operations; balancing, final straightening and inspection.

Machining the Peerless Crankshaft. Fred H. Colvin. Am. Mach., vol. 56, no. 17, Apr. 27, 1922, pp. 621–623, 6 figs. Machining crankshaft for eight-cylinder motor; double connecting rods require long crankpin bearings. Details of oiling and methods of drilling oil holes.

Cylinders, Casting. Cylinder Casting. Eng. Production, vol. 4, no. 86, May 25, 1922, pp. 493–496, 10 figs. Methods used in Midland Motor Cylinder Co., Ltd., near Birmingham.

Cylinders, Renewing. Renewing Cylinders. Paul Dumas. Motor Age, vol. 41, nos. 20 and 21, May 18 and 25, 1922, pp. 16–20 and 16–20, 17 figs. May 18: Equipment and tooling-up. May 25: Parts machining and fitting.

Ignition. Automobile Ignition. Chas. Baxter. Engineering, vol. 113, no. 2941, May 12, 1922, pp. 578–579, 10 figs. Investigation with view to bringing out relative methods of magneto and coil for battery systems.

Regrinding Parts. Regrind Automobile Engine Parts. F. B. Jacobs. Abrasive Industry, vol. 3, no. 4, Apr. 1922, pp. 118–121, 6 figs. Worn cylinders are reground and fitted with oversize pistons and rings; crankshaft regrinding must be performed accurately.

AUTOMOBILE FUELS

Alcohol. Alcohol Motor Fuel Research. Motor Transport, vol. 34, no. 898, May 15, 1922, pp. 600–601, 6 figs. Encouraging interim report issued by Empire Motor Fuels Committee of Imperial Motor Transport Council.

AUTOMOBILE INDUSTRY

Renault Works, France. The Works of the Société Anonyme Renault. Engineering, vol. 113, no. 2943, May 26, 1922, pp. 639–643, 11 figs. Description of 640,000-sq. yd. plant which manufacturers own iron and steel castings, rolls metal to their own dimensions; develops 15,000 h.hp.

AUTOMOBILES

American in Argentine. The American Automobile Holds Dominant Place in Argentine Republic. Automotive Industries, vol. 46, no. 19, May 11, 1922, pp. 1024–1025. American car will hold its position because of many requirements, giving service, and low price.

Axles, Rear. A Dual Reduction Rear Axle. Fred H. Colvin. Am. Mach., vol. 56, no. 18, May 4, 1922, pp. 663–665, 12 figs. Cutting-off, drilling, boring and milling methods on a forged axle. Fixtures which facilitate easy handling.

Brake Couplings. Are Cables Superior to Rods for Brake Couplings? M. W. Bourdon. Automotive Industries, vol. 46, no. 20, May 18, 1922, pp. 1059–1060, 8 figs. European makers claim cables stronger. Sunbeam, Minerva, Ansaldo, Lorraine-Dietrich, and La Licorne furnish some excellent examples of current practice.

Cubitt Car, British. British Cubitt Car Designed to Compete with American Products. M. W. Bourdon. Automotive Industries, vol. 46, no. 19, May 11, 1922, pp. 1006–1009, 8 figs. New British model designed for quantity production to compete with low-priced American cars in home market. Has 4-cylinder $3^1/_8 \times 5^1/_2$-in. engine 4 speeds, worm drive and cantilever springs.

Design. Modern Tendencies in Automobile Construction (Zur Kritik der neuen Richtlinien im Automobilbau). R. Conrad. Motorwagen, vol. 25, nos. 4, 5 and 6, Feb. 10, 20 and 28, 1922, pp. 63–73, 83–87 and 105–115, 52 figs. Feb. 10: Hydraulic gears; gears in constant engagement with relay couplings; possiblities of standardization. Feb. 20: Construction of light pistons and cylinders for two- and four-stroke engines. Feb. 28: Describes some recent two-stroke engines; suction and compression; improvements in driving; adding new speeds for slow driving; etc.

Differential. With and Without the Differential. Louis Coatalen. Autocar, vol. 48, no. 1385, May 6, 1922, pp. 741–743. Reply to Granville E. Bradshaw's rejoinder. Evolution of touring car is based on racing practice; why solid axle is used on some racings cars; used on small cars because it permits better spring suspension.

Manufacture. Better Cars at Lower Price; A Production Achievement. J. E. Schipper. Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1147–1149 and 1157. Marketing and production closely allied. Machine-tool development important. Careful shop planning major factor in ability to join quality with quantity production.

Short-Ashby Light Car. The Short-Ashby Light Car. Auto, vol. 27, no. 1115, May 18, 1922, pp. 405–408, 9 figs. Excellent example of friction-driven car, with some interesting mechanical features. Ruby 4-cylinder engine, 8 hp.

Sport. The Design of Sporting Cars. F. Gordon Crosby. Autocar, vol. 48, no. 1380 and 1381, Apr. 1 and 8, 1922, pp. 521–523 and 578–580, 12 figs. Apr. 1: Describes special type of body combining comfort with smart appearance April 8: Difficulties in connection with convenient and aesthetic mounting of important accessories.

Starter Armature. Novel Starter Amature Eliminates Use of Soldered Commutator Joint. Automotive Industries, vol. 46, no. 21, May 25, 1922, p. 1108, 2 figs. Closed end of armature coil located at what is usually commutator end. Separate commutator dispensed with. Two armature bearings are placed closer together. Simplified construction greatly reduces production cost.

Surrey Light Car. The Surrey Light Car. Auto, vol. 27, no. 1116, May 25, 1922, pp. 425–427, 10 figs. Vehicle of sound design with good record of competitive achievement; Coventry-Simplex "O. E." type, 4-cylinder monobloc 10.5 hp. engine.

Suspension Design. The Design of Motor Car Suspensions. A. A. Remington. Automobile Engr., vol. 12, no. 163, May 1922, pp. 139–141, 2 figs. Consideration of factors involved and some conclusions.

Suspension Springs. European Makers Adopt Quarter Elliptic Springs for Light Cars. M. W. Bourdon. Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1153–1157, 18 figs. Modifications in original application have been found necessary in practice. Standard and Wolseley offer good examples of "safety leaf." Carrow shows use of radius rod in construction.

AVIATION

Air Ports, Organization of. The Organization of Airports. Aviation, vol. 12, no. 23, June 5, 1922, pp. 660–662, 4 figs. Information division, air service issues revised specifications and rules for ground organization.

Gliders. See FLIGHT, Soaring.

Light, Use in. The Use of Light as an Aid to Aerial Navigation. L. F. Blandy. Illuminating Engr., vol. 15, no. 2, Feb. 1922, pp. 42–58 and (discussion) 58–63, 8 figs. Lights carried on aircraft, internal and external; aerodrome lighting; ground illumination; aerial light houses.

B

BATTERIES

E.M.F. at Low Temperatures. Electromotive Force of Cells at Low Temperatures. G. W. Vinal and F. W. Altrup. Sci. Papers of Bur. of Standards, no. 434, Apr. 17, 1922, pp. 627–634, 2 figs. Experiments of temperatures as low as —170 deg. cent. when high values of voltage were sometimes observed and polarity was often reversed.

BEAMS

Calculation. Expansion of the Clapeyron Equation (Erweiterung der Clapeyronschen Gleichung). Edgar Schmidt. Eisenbau, vol. 13, no. 4, Apr. 21, 1922, pp. 71–77, 7 figs. Assumes statically indeterminate main systems for derivation of this equation to simplify work of calculating beams with n supports.

Deflection. Some Problems in Deflection of Beams. Ewart S. Andrews. Concrete & Constructional Eng., vol. 17, no. 4, Apr. 1922, pp. 235–243, 4 figs. Gives derivation of formulas for deflection of beams for two cases not usually dealt with in textbooks.

BELTING

Leather. Power Transmission by Belting. P. F. O'Shea. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 814–816, 4 figs. Characteristics of leather belting and charts for simplifying calculations.

Leather, Laboratory Tests. Method of Tests on Leather Belt and Laboratory Equipment. L. W. Arny. Belting, vol. 20, no. 5, May 1922, pp. 31–32, 2 figs. How research into many perplexing problems is conducted by leather belting exchange foundation at Sibley College of Mech. Eng., Cornell.

Steel. Machinery Driven by Steel Belt. John D. Knox. Iron Trade Rev., vol. 70, no. 16, Apr. 20, 1922, pp. 1114–1116, 6 figs. Endless steel bands rolled from seamless tubing have wide application for transmitting power; slippage is overcome by facing pulleys with cork; relation of pulley speeds is discussed.

BLAST-FURNACE GAS

Cleaning Methods, Comparison. Gas Cleaning Methods Compared. N. H. Gellert. Iron Trade Rev., vol. 70, no. 20, May 18, 1922, pp. 1401–1406, 4 figs. Analysis of relative merits of dry and wet cleaning systems with formulas and tabular data supplying specific information; concludes that hot-cleaned gas effects a fuel economy.

Value of Clean. The Value of Clean Blast-Furnace Gas. N. H. Gellert. Mech. Eng., vol. 44, no. 5, May 1922, pp. 305–310. 3 figs. Savings resulting from use of clean gas in hot-blast stove and boiler operation. Superiority of dry cleaning over wet cleaning. Possibilities held out by electrical cleaning process.

Washing Losses. Analyzing Gas Washing Losses. H. T. Watts. Iron Trade Rev., vol. 70, no. 17, Apr. 27, 1922, pp. 1179–1181. Causes of heat losses in wet washing of blast furnace gas are outlined and amount of loss is calculated. Effects of stoves and vapor content are considered.

BLAST FURNACES

Charging. Notes on Blast Furnace Filling. D. E. Roberts. Engineering, vol. 113, no. 2941, May 12, 1922, pp. 599–603, 16 figs. Relative advantages of skip and bucket systems. Paper read before Iron & Steel Inst.

Filling. Notes on Blast-Furnace Filling. D. E. Roberts. Iron & Steel Inst. advance paper no. 9, meeting May 1922, 17 pp., 14 figs. partly on supp. plates. Description of skip and bucket methods of mechanical charging.

Lining Failures. Lining Failures Caused by Zinc. P. O. Menke. Iron Trade Rev., vol. 70, no. 20, May 18, 1922, pp. 1409–1410. This element in ores and limestone causes deterioration; effect is accumulative; water cooling above mantle seems to accelerate action; recommends heavier plates.

Remodeling. Rebuilds Eastern Blast Furnace. Richard Peters, Jr. Iron Trade Rev., vol. 70, no. 18, May 4, 1922, pp. 1258–1260, 4 figs. Thomas Iron Co. in modernizing historic plant at Hokendauqua, Pa. completely reconstructs stack no. 3; new equipment includes buildings, power plant and auxiliary apparatus; provision is made for future expansion.

BOILER FEEDWATER

Characteristics. The Story of Feed Water, M. F. Newman. Combustion, vol. 6, no. 6, June 1922, pp. 275–278, 5 figs. Impurities which cause trouble and suggested plan for feedwater.

Heating. Heating Feedwater by Steam From Turbines (Réchauffage de l'eau d'alimentation par prélèvement de vapeur aux turbines), R. de Kergaradec. Génie Civil, vol. 80, no. 17, Apr. 29, 1922, pp. 380–383, 2 figs. Makes calculations of savings effected; draws attention to some modifications required in boiler equipment.

BOILER FIRING

Oil-Firing System. The New Körting Oil Firing System (Neue Körting-Oelfeuerungen), Pradel. Petroleum, vol. 18, no. 13, May 1, 1922, pp. 481–486, 8 figs. Describes new steam jet or compressed-air centrifugal atomizer recently put on market, and gives examples of its application.

Oil-Fuel. Oil Firing Sixty-four Boilers at Amoskeag. Power, vol. 55, no. 24, June 13, 1922, pp. 920–923, 5 figs. Features of installation at Manchester, N. H., which eliminates factors of coal firing objectionable in textile plant.

BOILER MAKING

Babcock & Wilcox French Plant. The Works of the French Babcock & Wilcox Co., Engineering, vol. 113, no. 2944, June 2, 1922, pp. 674–676, 7 figs. Description of plant covering 153,600 sq. yd. and containing 8 large buildings in which all operations are carried on.

BOILER OPERATION

Colfax Station. Boiler-Room Performance and Practice of the Colfax Station, Duquesne Light Company, C. W. E. Clarke. Mech. Eng., vol. 44, no. 5, May 1922, pp. 295–300, 8 figs. Description of plant of Duquesne Light Co., Cheswick, Pa., and some details of its operation and performance.

Efficiency. New Practical Industrial Method of Using Boilers (Nouvelle méthode industrielle pratique pour l'exploitation rationnelle des générateurs de vapeur), H. Carra. Chaleur & Industrie, vol. 3, nos. 23 and 24, Mar and Apr. 1922, pp. 1049–1056 and 1158–1164, 9 figs. Discusses essentials of combustion and analysis of losses in heat production, measurement and control of these losses, leading to quasi-automatic control.

BOILER PLANTS

Production Cost. Production Costs and Boiler Plants, W. S. Johnston. Combustion, vol. 6, no. 6, June 1922, pp. 285–288. General discussion of expenses with suggestions for plant enlargements or renewals as deduced from modern achievements.

BOILER PLATES

Cracks. Formation of Cracks in Boiler Plates, B. Strauss and Ad. Fry. Forging & Heat Treating, vol. 8, no. 5, May 1922, pp. 225–229, 23 figs. Force influence figures developed by new etching method permit recognition of brittleness. Tests show that rolled plates should be finished at as high a temperature as possible. Translated from Stahl und Eisen, Aug. 18, 1921.

BOILER TUBES

Charcoal Iron. Installing and Maintaining Charcoal Iron Locomotive Boiler Tubes, C. H. Woodroffe and C. E. Lester. Ry. Mech. Engr., vol. 96, no. 5, May 1922, pp. 274–278, 13 figs. Use of welding in tube work, with particular reference to recommended maintenance practice in enginehouses. Describes effective flue-shop equipment and layout.

BOILERS

Centralized Combustion Control. Centralized Combustion Control for Boilers. Power, vol. 55, no. 20, May 16, 1922, pp. 771–774, 8 figs. Operation of automatic control for bank of boilers thereby maintaining constant character of combustion at all loads.

Developments. Recent Boiler Developments, V. Z. Caracristi. Steam, vol. 29, no. 5, May 1922, pp. 123–128. Removal of limitations as to pressure, size and output by recent development; covers any present-day power.

Seams, Efficiency of. Calculating the Efficiency of Boiler Seams, R. J. Finch. Boiler Maker, vol. 22, no. 5, May 1922, pp. 126–129, 5 figs. Tables reduce chance for error and facilitate work; points where failure is likely to occur.

Steam Heating. Water Returns to Steam Heating Boilers. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 3, Apr. 1922, pp. 338–342, 1 fig. Proper return connections to heating boilers when set in battery of two or more, and application of check valves. Report prepared by representatives of engineering staffs of insurance companies writing steam-boiler insurance in United States.

[See also LOCOMOTIVE BOILERS, MARINE BOILERS.]

BOILERS, WATER-TUBE

Spearing. Spearing Water-tube Boiler, Elec. Rev., vol. 90, no. 2320, May 12, 1922, pp. 652–655, 6 figs. Characteristics including sectional headers, downcomer pipes, reservoir mud drum.

Vertical. Thermal Principles in the Construction of Modern Vertical Water-Tube Boilers (Bau- und warmetechnische Grundsätze für den Bau neuzeitige Steilrohrkessel), Berner. Wärme, vol. 45, no. 14, Apr. 7, 1922, pp. 165–169, 14 figs. Discusses these principles in connection with a Müller boiler, including circulation of water and steam, superheating, boiler settings; results of efficiency tests.

BRASS

Cartridge, Physical Properties of. Physical Properties of Cartridge Brass, C. Upthegrove and W. G. Harbert. Trans. Amer. Inst. Min. & Met. Engrs. issued with Min. & Metallurgy, May 1922, no. 1161-N, 10 pp., 8 figs. Some data bearing on effect of anneal previous to final reduction or rolling on hardness.

Corrosion and Dezincing. Selective Corrosion and Dezincing of Brass Parts (Selektive Korrosionen und Entzinkungerscheinungen an Messingteilen), F. v. Wurstemberger. Zeit. fur Metallkunde, vol. 14, nos. 1 and 2, Jan. and Feb. 1922, pp. 23–29 and 59–69, 26 figs. Explains dezincing as a double process of an anodic dissolution of metal and a cathodic precipitation of copper; elimination of corrosion.

BRONZES

Manganese. Occurrence of Blue Constituent in High-strength Manganese Bronze, E. H. Dix, Jr. Trans. Amer. Inst. Min. & Met. Engrs. issued with Min. & Metallurgy, May 1922, no. 1158-N, 16 pp., 19 figs. Study of this feature discovered during investigation of high-strength manganese bronze by Eng. Division of Air Service.

Manganese Bronze in Engineering Work. Iron Age, vol. 109, no. 22, June 1, 1922, pp. 1513–1515, 5 figs. How it is made in large foundry; its properties in castings and rolled form; typical installations.

C

CALCULATING MACHINES

Mercedes-Euclid. A Machine That Thinks (Mitteilungen aus der Praxis). Technische Blätter, vol. 12, no. 20, May 20, 1922, pp. 204–206, 3 figs. Describes Mercedes-Euclid arithmetical machine and gives details of its operations in adding, subtracting and multiplication.

CAR WHEELS

Cast-Iron. Metal for Cast Iron Car Wheels, Y. A. Dyer. Iron Age, vol. 109, no. 22, June 1, 1922, pp. 1504–1506. Three distinct compositions embodied in one mass: white, gray and mottled; care necessary in blending cupola charges.

Chilled-Iron. An Investigation of the Properties of Chilled Iron Car Wheels, J. M. Snodgrass and F. H. Guldner. Univ. Ill. Bul. no. 129, vol. 19, May 1, 1922, pp. 9–95, 44 figs. Requirements of car wheels and tests of this type.

Thermal Stresses in Chilled Iron Car Wheels, G. K. Burgess and R. W. Woodward. Technologic Papers of Bur. of Standards, no. 209, Mar. 18, 1922, pp. 193–226, 26 figs. Stresses calculated from strain-gage measurements.

Cushion, Flanged. Flanged Cushion Wheel of New Design. Elec. Traction, vol. 28, no. 5, May 1922, pp. 420–421, 4 figs. New type of Mead cushion wheel for passenger coaches has features which have proven to be practical.

Tire Rolling. A New Departure in Tire Rolling. Ry. Gaz., vol. 36, no. 18, May 5, 1922, pp. 735–736, 6 figs. Describes system for production of railway tires which has recently been installed by leading firm of manufacturers.

CARBURETORS

Setting for Airship Engine. The Determination of a Carburetor Setting for the Liberty Engine for Dirigible Use. Air Service Information Circular, vol. 4, no. 311, Mar. 15, 1922, 8 pp., 2 figs. Results of test to develop a carburetor setting for Liberty 12-cylinder engine adapting it for dirigible service.

CARS, FREIGHT

Corrugated Steel Roof. A Self-Supporting Corrugated Steel Freight Car Roof. Ry. Age, vol. 72, no. 19, May 13, 1922, pp. 1129–1130, 2 figs. Describing new design placed on market by Sharon Pressed-Steel Company.

CASE-HARDENING

Carburizing. Recommended Practice in Carburizing, S. P. Rockwell. Am. Mach., vol. 56, no. 22, June 1, 1922, pp. 811–812. Suggestions for selection of carburizing material; methods of testing it; best materials for different kinds of work; design and use of carburizing pots. Paper read before Am. Gear Mfrs. Assn.

Penetrability of Carbon. The Penetration of Carbon Into Metals and Mixed Crystals of Iron (Ueber die Diffusion des Kohlenstoffs in Metalle und die Mischkristalle des Eisens), Gustav Tammann. Stahl u. Eisen, vol. 42, no. 17, Apr. 27, 1922, pp. 654–658, 9 figs. Coefficient of penetrability of carbon and effect of molybdenum, cobalt, manganese, tungsten, etc., on depth of penetration.

Steel, Quality of. Effect of Quality of Steel on Case-Carburizing Results, H. W. McQuaid and E. W. Ehn. Forging & Heat Treating, vol. 8, nos. 5–6, May and June, 1922, pp. 243–247, 274–278, 46 figs. Effect of non-metallic impurities and alloy elements on final results in hardening of case-carburized steel. Paper presented Feb., 1922 at A.I.M.E.

CAST IRON

Carburization. A Study of Carburization in Manufacture of Synthetic Cast Iron, C. E. Williams and C. E. Sims. Amer. Electrochem. Soc., advance paper, no. 13, meeting Apr. 27–29, 1922, 8 figs. Investigation of factors which influence carburization.

Chemical Composition. Cast Iron and Its Chemical Composition, O. Smalley. Foundry Trade Jl., vol. 25, nos. 298 and 299, May 4 and May 11, 1922, pp. 323–326, and 343–345, 16 figs. Study of little known elements in cast iron which have kept mechanical characteristics from being controlled. Paper read before Inst. of British Foundrymen.

Electrical Melting. Melts Gray Iron Electrically, W. E. Cahill. Foundry, vol. 50, no. 10, May 15, 1922, pp. 420–421. Cheap current makes it profitable to melt both iron and steel for castings electrically; power consumption figures given; iron produced has uniformly fine grain.

Synthetic, Carburization of. Carburize Synthetic Cast Iron, Clyde E. Williams and C. E. Sims. Foundry, vol. 50, no. 10, May 15, 1922, pp. 390–393 and 422, 8 figs. Experiments made in introducing commercial forms of carbon; details of operation and results; effects of slags and various elements contained in iron are studied.

CASTING

Continuous. Improving Casting Methods in Steel Works (Amélioration des procédés de coulée dans une aciérie), Lucien Dujardin. Outillage, Tome 256, no. 16, Apr. 22, 1922, pp. 475–477, 6 figs. Discusses continuous casting in order to increase production, and describes foundry arrangements necessary.

CASTINGS

Centrifugal. Producing Centrifugal Castings, Leon Cammen. Iron Trade Rev., vol. 70, no. 17, Apr. 27, 1922, pp. 1188–1193, 3 figs. Methods of making hollow metal objects and machine used are described. Uniform cooling of poured metal makes manufacture of thin tubes possible; believes process may be applied to plate making. Presented at A.S.M.E. Spring Meeting May 1922.

CEMENT

Alumina. Alumina Cement; Its Development, Use and Manufacture, Henry S. Spackman. Eng. News-Rec., vol. 88, no. 20, May 18, 1922, pp. 831–834. History and properties of high strength, quick setting cement now being produced commercially in France.

CEMENT MANUFACTURE

Clinker Burning. Heat Distribution in Burning Cement Clinker, Elliott H. Whitlock and Charles E. Burgoon. Concrete, vol. 20, no. 5, May 1922, pp. 111–118, 14 figs. Study of variable conditions with view to improving efficiency of operation from engineering standpoint.

Segregation. Segregation, Charles Catlett. Concrete, vol. 20, no. 5, May 1922, pp. 119–124. Results of original investigation and segregation as applied to cement industry.

CENTRAL STATIONS

Calumet Plant, Chicago. Calumet to Reinforce Industrial Section of Chicago System. Elec. World, vol. 79, no. 22, June 3, 1922, pp. 1111–1114, 6 figs. New station of Commonwealth Edison Co. has 15,089 sq. ft. boilers with integral economizers and forced-draft chain grates; steam is bled from prime movers for heat balance. See also Elec. Ry. Jl., vol. 59, no. 22, June 3, 1922, pp. 897–901, 6 figs.

Calumet Station, Commonwealth Edison Co. Power, vol. 55, no. 22, May 30, 1922, pp. 842–850, 10 figs. Initial installation, 60,000 kw. Steam supplied to turbines at 300 lb. pressure and 200 deg. superheat. System for 15,089 sq. ft. boilers designed for 350 lb. and 250 deg. superheat. Other features of installation.

Economic Operation. Economic Production of Power and the Technical Side of Super-Central Stations (La production économique de l'énergie et la technique des super-stations centrales), A.-R. Garnier. Technique Moderne, vol. 14, nos. 2, 3 and 4, Feb., Mar. and Apr. 1922, pp. 63–69, 106–112 and 167–170, 9 figs. Feb.: Modern tendencies in mass production of power, including steam driving of turbines, superheat, handling of fuel, air preheating. Mar.: Technical aspects of superpower stations, including simplification of conduits, increase in power per unit, turbines and their characteristics. Apr.: Discusses electrical equipment, especially close connection between turbine and generator.

Operation. Performance of Equipment and Trends in Station Practice. Elec. World, vol. 79, no. 20, May 20, 1922, pp. 1033–1035, 1 fig. Analysis of turbine outages and operating data for powdered-fuel, Diesel and oil plants constitute important part of report of N.E.L.A. Com. on Prime Movers this year.

Superpower. The Gennevilliers Central Station (La Centrale de Gennevilliers). Special Number of Chaleur & Industrie, pp. 14–54, 29 figs. Details of superpower station constructed by Union d'Electricité, especially boiler-room equipment, condensers, economizers, boilers, etc.

CHAIN DRIVE

Tooth Grinding. Grinding Inverted Tooth Chain Wheels. Eng. Production, vol. 4, no. 85, May 18, 1922, pp. 474–475, 4 figs. Outline of method by which flanks of inverted-tooth chain-wheel teeth may be accurately ground to correct dimensions and angles, and machinery for grinding wheels of any pitch, width, and number of teeth.

CHARTS

Construction. Principles of Constructing Charts (Coup d'oeil sur les principes fondamentaux de la nomographie), M. d'Ocagne. Révue Générale des Sciences, vol. 33, no. 8, Apr. 30, 1922, pp. 230–239, 9 figs. Discusses cases in which more than three variables can be reduced to graphic presentation on a plane.

CHROMIUM STEEL

Spontaneous Passivity. Spontaneous Passivity of Chromium Steels (Die spontane Passivität der Chromstähle), G. Tammann. Stahl u. Eisen, vol. 42, no. 15, Apr. 13, 1922, pp. 577–578, 1 fig. Behavior of chromium steels and electrolytes and protective effect of chromium.

CLUTCHES

Magnetic. Magnetic Clutches for Machine Driving. C. Sylvester. Eng. Production, vol. 4, no. 86, May 25, 1922, pp. 491–492, 2 figs. Notes on their design, application and working.

COAL

Combustion. The Combustion of South African Coals in Boiler Furnaces. E. P. Reim. So. African Eng., vol. 33, nos. 3 and 4, Mar. 31 and Apr. 29, 1922, pp. 40, 73–75. Mar. 31: Origin and mode of formation of coal; impurities. Apr. 29: Describes combustion characteristics. From paper read before Chem., Metallurgical & Min. Soc. of So. Africa.

Recovery from Ashes. Recovering Coke and Coal From Ashes (Die Wiedergewinnung von Koks und Kohle aus Feuerungsrückständen). F. Schulte. Glauckauf, vol. 58, no. 18, May 6, 1922, pp. 534–537, 5 figs. Recovery systems of Weber, Hessel, Schilde, and Ullrich, and thei- advantages and disadvantages.

Spontaneous Combustion. Microscopical Examination of Batt. James Lomax. Colliery Guardian, vol. 123, no. 3199, Apr. 21, 1922, pp. 975–977 (includes discussion), 21 figs. Microscopical research carried on for describing the various forms of pyrites or iron disulphide found in coal, its origin and probable effects in relation to spontaneous combustion. Paper read before Manchester Geological & Min. Soc. See also Iron & Coal Trades Rev., vol. 104, no. 2825, Apr. 21, 1922, pp. 577–578.

COAL HANDLING

Conveyor, Shaking. Horizontal Reciprocating Conveyor and Screen on a New Principle, Alphonse F. Brosky. Eng. & Indus. Management, vol. 7, no. 13, May 4, 1922, pp. 407–410, 10 figs. This device is manipulated by revolving weights and spring supports whereby compound motion is obtained and coal is caused to travel forward continuously. By duplicating opposing parts useless vibration is prevented.

Conveyors. Tells How Conveyor Saved Money for Plant, A. MacLean. Black Diamond, vol. 68, no. 18, May 6, 1922, p. 429, 1 fig. Description of Barber-Greene Conveyor which operated for five years without requiring repairs and handles coal and ashes at thirteen cents a ton, including labor.

Docks. The Coaling Devices of the Suisted Elevator Company at the Victoria and Albert Docks, Geo. F. Zimmer. Eng. & Indus. Management, vol. 7, no. 14, May 18, 1922, pp. 435–440, 7 figs. Description of machines designed by Suisted Elevator Co. and ultimate successful accomplishment.

Industrial Plants. Coal and Ash Conveying for Boiler Rooms (Bekohlung und Entaschung im Kesselbetriebe), R. Dub. Fördertechnik u. Frachtverkehr, vol. 15, nos. 9 and 10, Apr. 28 and May 12, 1922, pp. 123–127 and 138–144, 16 figs. Apr. 28: Storing and conveying of coal from factory coal pile by means of conveyors, cranes, etc. May 12: Mechanical feeding of coal to boiler house in a number of large central stations.

Power. Handling Coal by Power, James B. Hayden. Combustion, vol. 6, no. 6, June 1922, pp. 268–272, 6 figs. Desirability of mechanical devices and suggestions for planning same.

COKE

Blast Furnace and Foundry. Testing of Coke for Blast Furnace and Foundry Purposes (Vorschläge zur Prüfung des Kokses für Hochofen- und Giessereizwecke), Heinrich Koppers. Stahl u. Eisen, vol. 42, no. 15, Apr. 13, 1922, pp. 569–573, 4 figs. Properties of metallurgical coke, ease of combustion, porosity, and different requirements of coke for blast furnaces and foundries.

COKE OVENS

Piette. Piette Coke Oven Consumes a Little Over One-Third of the Heat in Its Gases, Hector Prud'-Homme. Coal Age, vol. 21, no. 24, June 15, 1922, pp. 1003–1005, 1 fig. Makes almost 70 per cent of coal into coke, about 5½ lb. of ammonia, 7 gal. of tar and 3½ gal. of benzine; long oven life anticipated.

COMBUSTION

Spontaneous. Spontaneous Combustion and Friction, Walter L. Wedger. Fire & Water Eng., vol. 71, no. 15, Apr. 12, 1922, pp. 603–604 and 614. Notes on substances subject to spontaneous ignition; coal, fibers and wood charcoal said to be very susceptible; friction fires caused by foreign substances.

COMPRESSED AIR

Motive Power, as. Compressed Air as Motive Power (Energiewirtschaft beim Pressluftbetriebe), A. Hinz. Glückauf, vol. 58, no. 20, May 20, 1922, pp. 581–589, 4 figs. Discusses storing of compressed air for power purposes and examines mathematically process in air compressors, piston compressors and turbo-compressors, and determines their efficiency.

Pneumatic Mail Dispatch. Pneumatic Tubes in the United States for Mail—German Types (Rohrposten für Briefbeutel in den Vereinigten Staaten von Nordamerika; deutsche Bauarten), Schwaighofer. Organ für die Fortschritte des Eisenbahnwesens, vol. 77, no. 5, Mar. 1, 1922, pp. 65–70, 5 figs. Discusses postal tube services in Chicago, New York, Philadelphia and St. Louis, and makes comparison with German parcel tubes.

COMPRESSORS

Ammonia. See AMMONIA COMPRESSORS.

CONCRETE

Abrasion Test. New Laboratory Abrasion Test for Concrete, C. H. Scholer. Cement & Eng. News, vol. 34, no. 4, Apr. 1922, pp. 23–24, 4 figs. Test being developed by Engineering Experiment Station of Kansas State Agricultural College, 9-in. spheres of concrete cast and tested after proper aging and curing. Tested in standard brick rattler using standard abrasive charge.

Central-Plant-Mixed. Central-Plant-Mixed Concrete Tested for Safe Haul, James W. Brooks. Contractors' & Engrs.' Monthly, vol. 4, no. 4, Apr. 1922, p. 48. Description of tests made to determine safe maximum length of haul.

Fastening Machinery to. Fastening Machinery to Concrete, G. H. Radebaugh. Brick & Clay Rec., vol. 60, no. 11, May 30, 1922, pp. 848–851, 12 figs. Practices which have been found successful in working with hard concrete; procedure outlined step by step.

COPPER ALLOYS

Cupro-Nickel, Cold-Work and Recrystallization. The Internal Mechanism of Cold-Work and Recrystallisation in Cupro Nickel, Frank Adcock. Metal Industry (Lond.), vol. 20, nos. 16 and 17, Apr. 21 and 28, 1922, pp. 372–374 and 392–394, 21 figs. Experiments for gathering information on process of cold-work and recrystallization of metals.

CORE OVENS

Electric vs. Oil-Fired. Core-oven Tests, F. L. Wolf and A. A. Grubb. Am. Inst. Min. & Met. Engrs. Trans. advance paper, no. 1152-N, Apr. 1922, 13 pp., 2 figs.; also (abstract) in Min. & Metallurgy, no. 184, Apr. 1922, pp. 37–38, 2 figs. Describes tests to obtain information regarding costs, efficiency, etc. of baking cores in oil-fired oven and two electric ovens installed in 1920 in core room of Ohio Brass Co. Power and fuel costs favor oil, while quality and uniformity of bake, core losses, convenience and cost of tending, favor electricity.

CORROSION

Ferrous Metals. Corrosion of Ferrous Metals, Robert Abbott Hadfield. Engineering, vol. 113, no. 2936, Apr. 7, 1922, p. 419. Preparation of various ferrous metals used in corrosion research of Instn. Civ. Engrs. together with their physical and mechanical properties, and general considerations on subject of corrosion. (Abstract.) Paper read before (British) Instn. Civ. Engrs.

Prevention by Deactivation of Water. Control of Corrosion by Deactivation of Water, Frank N. Speller. Franklin Inst. Jl., vol. 193, no. 4, Apr. 1922, pp. 515–542, 13 figs. Outline of present status of corrosion prevention by deactivation and deaeration of water.

Sea-Water. Reducing Corrosion by Sea Water, Robt. Hadfield. Iron Trade Rev., vol. 70, no. 21, May 25, 1922, pp. 1481–1483, 3 figs. British conduct extensive investigation to determine best type of steel for under-water structural work; non-rusting steel containing 12 to 14 per cent chromium is found to be most satisfactory.

Water-Carrying Vessels, Prevention. Corrosion and Its Prevention in Vessels Carrying Water, J. R. McDermet. Am. Soc. Heat. & Vent. Engrs., vol. 28, no. 4, May 1922, pp. 407–416. Suggestions for reducing corrosion in water piping, boiler economizers, boilers, steam piping or water tanks.

COUPLINGS

Flexible. Universal Joints and Flexible Couplings; Their Kinds and Uses on Boats, Wm. Atkin. Motor Boat, vol. 19, no. 11, June 10, 1922, pp. 15–17, and 28, 12 figs. Consideration of necessity for flexible couplings.

CRANES

Electric. Electric Cranes At the Swiss Federal Railway Shops at Bellinzona. Engineering, vol. 113, no. 2943, May 26, 1922, pp. 653–654, 4 figs. Arrangement of two 80-ton electric traveling cranes for handling heavy electric locomotives.

Harbor. Cranes and Tipping Wagons for Loading and Unloading Ships (Kran und Kipper als Mittel zum Laden und Löschen von Wasserfahrzeugen), Wintermeyer. Fördertechnik u. Frachtverkehr, vol. 15, no. 8, Apr. 14, 1922, pp. 110–114, 11 figs. Discusses various types of cranes, electric drive, conveying platforms, etc.

Selection and Development of Double Cranes for Harbors (Über Wahl und Ausbildung von Doppelkranen fur Häfen), E. Krahnen. Fördertechnik u. Frachtverkehr, vol. 15, no. 8, Apr. 14, 1922, pp. 114–116, 8 figs. Describes new type of crane to expedite loading and unloading of ships. Combined Sction of two neighboring cranes.

Wharf, Hydraulic. Hydraulic Wharf Cranes. Shipbldg. & Shipg. Rec., vol. 19, no. 21, May 25, 1922, p. 684, 1 fig. Description of six 30-cwt. luffing cranes for port of London authority.

CUTTING TOOLS

Action of. The Action of Cutting Tools, E. G. Coker and K. C. Chakko. Engineering, vol. 113, no. 2940, May 5, 1922, pp. 564–569, 18 figs. Investigation of most efficient action of various tools for shaping metals and means of determining stresses set up.

Experiments. An Account of Some Experiments on the Action of Cutting Tools, E. G. Coker. Engineer, vol. 133, no. 3462, May 5, 1922, pp. 503–505, 12 figs. Means of studying stress distribution in cutting tools by polarized light.

D

DETONATION

Study of. The Background of Detonation, Stanwood W. Sparrow. Nat. Advisory Committee for Aeronautics Tech. Notes, no. 93, Apr. 1922, 17 pp., 5 figs. Consideration of several features of detonation problem which, it is claimed, have received comparatively little attention.

DIESEL ENGINES

Beardmore-Tosi The Beardmore-Tosi Marine Diesel Engine. Engineering, vol. 113, no. 2938, April 21, 1922, pp. 488–489, 4 figs. Description of main engines of single-screw motorship Pinzon.

Marine. North British Diesel Machinery for 2,000-ton Twin-Screw Vessels. Mar. Engr. & Naval Architect, vol. 45, no. 536, May 1922, pp. 204–206 and 207, 3 figs. Two sets of engines for British India Steam Navigation Co. vessels Dumra and Dwarka, developing 500 b.hp. on each of twin shafts and built by North British Diesel Engine Works, Glasgow.

Merchant Marine and Electrical Industries. Use of Diesel Engines in the Merchant Marine and in Electrical Industries (Les applications du moteur Diesel dans la marine de commerce et leurs conséquences au point de vue de l'industrie électrique), Yves Le Gallou. Revue Générale de l'Électricité, vol. 11, no. 15, Apr. 15, 1922, pp. 535–543. Conditions under which Diesel engines are used on board ship, for propulsion and for driving auxiliaries; its effect on development of electrical industry.

Power Plants. Diesels at Southend. Elec. Times, vol. 61, no. 1594, May 4, 1922, pp. 429–430, 3 figs. Rapid increase in demand for electric power met by successive installations of Diesel engines.

Power Plants, Application in. Diesel Engines and Examination into Their Economic Application (Dieselmotoren, Eine Untersuchung uber ihre wirtschaftliche Verwendung), Alfred Buchi. Schweizerische Bauzeitung, vol. 79, nos. 18 and 19, May 6 and 13, 1922, pp. 230–235 and 239–243, 11 figs. May 6: Compares hydroelectric with Diesel-electric power generation. May 13: Discusses Diesel engine installation in connection with water power works and gives cost calculation for water power only and water power with Diesel engines.

Submarine Type for Power Plants. Submarine Diesel Engines at Southend. Elec. Rev., vol. 90, no. 2321, May 19, 1922, pp. 688–690, 3 figs. Description of engines taken from dismantled German submarines and generating units which they operate.

Water-Works Power. Diesel Engines to Furnish Power for Water-Works, W. DeWitt Vosbury. Eng. News-Rec., vol. 88, no. 19, May 11, 1922, pp. 793–794, 2 figs. New station at Gloucester, N. J., to be equipped with motorized pumps and high economy, oil-engine-driven generators.

E

ELECTRIC COMMUNICATION

Aurora, Effects of. Effects of Aurora on Telegraphs, Telephones and Wireless in New Zealand. Telegraph & Telephone Age, no. 11, June 1, 1922, pp. 248–249. Report by A. Gibbs, deputy chief telegraph engr., on effects of auroral phenomenon generally, and those during exceptionally brilliant display.

ELECTRIC DRIVES

Installation. Protected Motor Service, T. W. C. Hartmann. Elec. Rev. & Indus. Engr., vol. 80, no. 5, May 1922, pp. 227–228, 257 and 262, 4 figs. Recent installation at Keystone Spring Works where electric drive has speeded up machine production.

ELECTRIC FURNACES

Carbon Steel. Electric Furnace Practice on Carbon Steel, L. J. Barton. Western Machy. World, vol. 13, nos. 4 and 5, Apr. and May 1922, pp. 134–137 and 173–175, 2 figs. April: Basic Operation. Two-slag practice in production of electric steel, with details of charging, melting down, chemical and other factors. May: Slagging and details of reducing period. Effects of high lime temperature tests. Finishing of heat.

Cast-Iron Production. Cast Iron as Produced in the Electric Furnace, and Some of Its Problems, George K. Elliott. Am. Electrochem. Soc. advance paper, no. 9, for meeting Apr. 27–29, 1922, pp. 75–87. Review of literature of electric-furnace cast iron. Discusses conditions favorable to electric furnace, and expresses preference for duplex process with basic-hearth electric furnace. Describes desulphurization and deoxidization; etc.

Electric Furnace Iron and Steel. Intermittent and Alternating Operations, W. E. Cahill. Am. Electrochem. Soc. advance paper, no. 6, for meeting Apr. 27–29, 1922, pp. 49–54. In Treadwell, Alaska, cast iron is made more cheaply in electric furnace than in cupola. Analyses figures show that from charges of all-scrap cupola-melted iron electric furnace produces metal of greatly reduced sulphur content.

Fiat. The Fiat Electric Furnace. Engineering, vol. 113, no. 2936, Apr. 7, 1922, pp. 421–422, 5 figs. partly on p. 424. Three-phase type, having a hearth slightly conductive, neutral and connected to earth. One of characteristic features is the Fiat economizer, or electrode holders.

Italian. Italian Electric Furnaces in Brazil (Forni elettrici italiani nel Brasile), Ettore Thover. Forno Elettrico, vol. 3, no. 9–10, Sept. 15-Oct. 15, 1921, pp. 115–119, 4 figs. Describes the Bassanese electric furnace plant at Juiz de Fora (Minas Geraes) having four 3-ton 400 kw. furnaces.

Metal-Melting. An A.C. Metal Melting Furnace (Ein elektrischer Metall-Schmeizofen für den Anschluss an Drehstrom), E. Fr. Russ. Elektro-

technische Zeit., vol. 43, no. 15, Apr. 13, 1922, pp. 497–499, 7 figs. Its development and practical application; can be directly connected to rotary current; furnace contains three electrodes allowing equal phase distribution.

Non-Ferrous. Metal Electric Furnaces, A. Glynne Lotley. Metal Industry (Lond.), vol. 20, nos. 14 and 15, Apr. 7 and 14, 1922, pp. 322–325 and 333–341 and (Discussion) 341–342, 6 figs. Examples of number of uses for electric furnaces not in iron and steel industry. Portion of report before Sheffield Section of Inst. of Metals.

Shaft and Open-Top. A Comparison Between Shaft and Open Top Furnaces in the Manufacture of Pig Iron Electrically from Iron Ore, R. C. Gosrow. Am. Electrochem. Soc., advance paper, no. 8, for meeting Apr. 27–29, 1922, pp. 63–74. Notes on stack and open-top type of furnace and combination open-stack type.

Types. Electric Furnaces and Electrometallurgy, Recent Patents (Les fours électriques et l'électrométallurgie d'après les brevets récents), L. Jumau. Revue Générale de l'Électricité, vol. 11, nos. 12 and 13, Mar. 25 and Apr. 1, 1922, pp. 436–441 and 463–468, 11 figs. Mar. 25: Describes Foley induction. Greiner resistance, Ferron, Moore, and other furnaces. Apr. 1: Electrodes; electric furnaces used in manufacture of steel and production of oxides of nitrogen.

ELECTRIC LOCOMOTIVES

Condensing Turbine. The Ramsay Condensing Turbine Electric Locomotive. Engineer, vol. 133, no. 3456, Mar. 24, 1922, pp. 328–329, 2 figs. Characteristics of experimental locomotive built by Armstrong, Whitworth & Co., Ltd.: Length overall, 69 ft. 7 in.; max. width, 8 ft. 3 in.; total weight, including 2200 gal. water for cooling purposes and 4 tons coal, 130 tons 15 cwt.; tractive force, 22,000 lb.; turbo-generator, 890 kw., at 3600 rev., voltage, 600. See also Ry. Rev., vol. 70, no. 19, May 13, 1922, p. 667.

Metropolitan Ry., London. 1,200-Hp. Electric Locomotives for the Metropolitan Railway. Engineering, vol. 113, nos. 2936 and 2938, Apr. 7 and 21, 1922, pp. 409–412 and 477–481, 32 figs. partly on supp. plate. Locomotives are 0-4-4-0 type and each have two bogie trucks of carriage type on which body is carried. Max. speed on non-stop runs is 60 mi. per hr.; electric supply is at 500 to 600 volts on third-rail system, and insulated negative return rail is laid in center of track; motors are of standard series-wound type with commutating poles. Describes control gears.

ELECTRIC PLANTS

Lausanne, Switzerland. Electric Installations of the City of Lausanne (Les installations électriques de la ville de Lausanne), G. Cauderay. Bul. Technique de la Suisse Romande, vol. 47, nos. 19, 21, 23, 24, Sept. 17, Oct. 15, Nov. 12 and 26, 1921, pp. 217–223, 7 figs., 241–248, 9 figs., 265–269, 8 figs. partly on pp. 270–272, 285–287, 3 figs., and vol. 48, nos. 6, 7 and 9, Mar. 18, Apr. 1 and 29, 1922, pp. 61–65, 5 figs., 73–78, 12 figs., and 103–105, 3 figs. partly on p. 102. Sept. 17: Discusses barrage of the Rhone and work connected with extension of plants. Oct. 15: Discusses work at Bois Noir; water header, turbines, alternators, transformers, etc. Nov. 12 and 26: Switching arrangements; servo-motors; cost details of construction work. Mar. 18: Describes transmission lines, poles, etc., also equipment of Pierre-de-Plan works. Apr. 1 and 29: Describes new Pierre-de-Plan works for receiving, transforming and distributing 50,000-volt current.

Waste-Fuel Utilization. Electricity from Limburg Waste Fuels (Electriciteitsopwekking uit Limburgsche afvalbrandstoffen), A. J. Ter Linden. Ingenieur, vol. 37, no. 15, Apr. 15, 1922, pp. 282–297, 26 figs. Use of low-grade fuels, brown coals, etc.; hand and mechanical stoking; results of tests that were made.

ELECTRIC RAILWAYS

Electrolysis and Inductive Interference. Effects of Electric Power Used for Traction, Chas. F. Scott. Ry. Elec. Engr., vol. 13, no. 4, Apr. 1922, pp. 113–116, 1 fig. Question of inductive interference and electrolysis as related to railway electrification.

Three-Coach Trains. Three-Coach Electric Trains of the London and North Western Railway. Tramway & Ry. World, vol. 51, no. 24, May 18, 1922, pp. 234–242, 29 figs. Description of suburban service, operating at 630 volts and several new and interesting features in connection therewith.

ELECTRIC WELDING, ARC

Structural Steel. Arc Welded Steel Building, B. C. Tracey. Welding Engr., vol. 7, no. 5, May 1922, pp. 24–25, 5 figs. Savings in time, labor and material; methods of making joints; welded joints pass tests.

The Arc Welding of Structurel Steel, E. S. Humphrys, Jr. Iron Age, vol. 109, no. 21, May 25, 1922, pp. 1422–1425, 7 figs. Tests made to determine reliability of welded joints and limiting conditions of various types of joints.

Utility. Utility Arc Welding. Engineer, vol. 133, no. 3458, Apr. 7, 1922, pp. 378–381, 8 figs. Describes what has been accomplished by small engineering firm by means of arc welding with considerable saving in time and money.

ELECTRICAL MACHINERY

Export Prospects for Latin America. Market Prospects for Electric Apparatus in Latin America and in Spain, Philip S. Smith. Elec. World, vol. 79, no. 15, Apr. 15, 1922, pp. 724–727, 4 figs. Opportunity in mining, agricultural and manufacturing fields. Status of power house, substation, transmission and railway electrification. Outlook for motor drive.

ENGINE HOUSES

Turntables. Railway Turntables. Ry. Engr., vol. 43, no. 508, May 1922, pp. 198–200, 5 figs. Technical consideration of energy required to move them and advantages of ball bearings for reducing friction.

EVAPORATORS

Vacuum, Marine Type. Vacuum Type of Evaporator Being Extensively Used on German Ships. Nautical Gaz., vol. 102, no. 19, May 13, 1922, p. 585. New device works automatically and requires very little watching. Has proved its efficiency on freighters. How operated in harbors.

EXHAUST STEAM

Utilization. The Utilization of Exhaust Steam from Electric Generating Stations, and Coal Economy, C. Ingham Haden. Instn. Elec. Engrs. Jl., vol. 60, no. 307, Mar. 1922, pp. 265–271 and (discussion) 273–286, 2 figs. Suggests combination of heat distribution with generation of electric current as possible means of using coal to better advantage, and proposes conversion of some of existing generating stations. Describes installations already carried out.

The Utilization of Waste Heat from Electrical Generating Stations, F. H. Whysall. Instn. Elec. Engrs. Jl., vol. 60, no. 307, Mar. 1922, pp. 271–272 and (discussion) 273–286, 1 fig. Suggestions based on author's personal experience of practical difficulties encountered.

F

FATIGUE

Failure By. Failure By Fatigue. Engineering, vol. 113, no. 2939, April 28, 1922, pp. 525–526. Doubts as to mathematical theory of elasticity; discussion and means of determining fatigue tendencies of material.

FERRONICKEL

Brittleness at Low Temperatures. On the Brittleness of Ferronickel at Low Temperatures (Étude de la fragilite des Ferronickels aux basses temperatures), P. Chevenard. Révue de Métallurgie, vol. 19, no. 4, Apr. 1922, pp. 209–214, 3 figs. Experiments to produce metal which would not become brittle at temperature of liquid air, to be used for accessories of liquid-air machines, and results.

FIRE ENGINES

Standardization. Standardization of Fire Engines (Zur Normung der Motorspritzen), Hüpeden. Feuerwehrtechnische Zeit., vol. 10, no. 3, Mar. 20, 1922, pp. 31–38, 6 figs. Discusses pump construction, quantity of water handled, motor construction and specifications generally.

Tilling-Stevens. New Tilling-Stevens Fire Engines. Motor Transport, vol. 34, no. 898, May 15, 1922, pp. 581–582, 5 figs. Three new fire pump vehicles have just been completed at Maidstone Factory, comprising large and medium self-propelling chassis and lightweight trailer.

FIREBRICK

Testing. New Methods for Determining Compression Strength and Softening of Firebrick at High Temperatures (Neue Verfahren zur Bestimmung der Druckfestigkeit und Erweichung feuerfester Ziegel bei hohen Temperaturen). Tonindustrie-Zeitung, vol. 46, no. 57, May 16, 1922, pp. 561–563. Reviews present methods and shows that there is as yet no uniform method of testing.

FLIGHT

Soaring. Experiments on Soaring Flight (Études expérimentales sur le Vol a Voile), P. Idrac. Aerophile, vol. 30, nos. 1–2, 3–4 and 5–6, Jan. 1–15, Feb. 1–15 and Mar. 1–15, 1922, pp. 4–9, 35–44 and 67–76, 46 figs. Discusses prolonged flight by birds without movement of wings and theories advanced to explain it; tests made; irregularities in wind velocity; vertical component of wind velocity; makes caclulation from experiments.

The "First Experimental Congress for Motorless Flight." Flight, vol. 14, no. 19, May 11, 1922, pp. 273–274, 1 fig. French soaring and gliding competition.

FLOW OF OIL

Pipes. Flow of Oil in Pipes. Lubrication, vol. 8, no. 4, Apr. 1922, pp. 45–48, 1 fig. Investigation of properties of oil and their effects on flow through pipes.

FLUE-GAS ANALYSIS

Unburned-Gas Determination. Incomplete Combustion and Furnace Control (Unvollkommene Verbrennung und Feuerungskontrolle), D. Haarmann. Feuerungstechnik, vol. 10, no. 16, May 15, 1922, pp. 173–176, 1 fig. Shows that CO determination of flue-gas should be supplemented by analysis for unburned gases.

FORGING

Hydraulic Bulging. Hydraulic Bulging and Bending. Machy. (Lond.), vol. 20, nos. 497, 498 and 499, Apr. 6, 13 and 20, 1922, pp. 8–12, 42–45 and 75–77, 43 figs. Apr. 6: Manufacture of gramophone swan necks and horn elbows. Apr. 13: Manufacture of telephone receiver cases. Apr. 20: Tooling for production of motor side lamp.

FOUNDATIONS

Bracing. Caisson Cofferdam Foundation With Special Bracing, T. Kennard Thomson. Eng. News-Rec., vol. 88, no. 22, June 1, 1922, pp. 914–918, 6 figs. Deep cellar substructure in filled ground, First Nat. Bank of Jersey City; Caissons braced by built-up struts during excavation; toe wall holds caissons against sliding; waterproofing.

FOUNDRIES

Blast Meter, Use of. Use of a Blast Meter in Foundry Practice, Louis L. Vayda. Iron Age, vol. 109, no. 23, June 8, 1922, pp. 1584–1586, 5 figs. Measurement of air blast volume important in cupola control; methods of measurement.

Brass. Brass Foundry Equipment, William H. Parry. Metal Industry (N. Y.), vol. 20, no. 5, May 1922, pp. 179–180. List of materials and supplies required for brass foundry melting five tons of metal per day.

Electricity in. Foundry Employs Electricity for Melting and Annealing, Herbert R. Simonds. Iron Trade Rev., vol. 70, no. 22, June 1, 1922, pp. 1567–1570, 8 figs. Description of units employed by Eastern manufacturer shows electrical equipment affects economies.

Motor Castings. A New Canadian Motor Foundry Plant. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1068–1070, 6 figs. How old plant was made into new one, designed with view to future expansion. Machine molding a feature in plant of Hiram Walker & Sons Metal Products Co., Ltd., Walkerville, Ont.

Textile Machinery. A New Textile Machinery Foundry. Iron Age, vol. 109, no. 22, June 1, 1922, pp. 1499–1503, 7 figs. Machine molding and machine sand handling are features; old foundry transformed into cleaning room.

FOUNDRY EQUIPMENT

Pneumatic Tools. Pneumatic Tools in Foundry Practice, Jas. W. Anderson. Compressed Air Mag., vol. 27, no. 6, June 1922, pp. 163–166, 9 figs. Increased production resulting from adoption.

FUEL ECONOMY

France. Reducing the Cost of Motive Power (Réduction des depenses de force motrice), Ch. Molette. Outillage, Tome 259, no. 19, May 13, 1922, pp. 604–605. Generally discusses question of efficiency and shows that in nearly all cases a saving of from 10 to 20 per cent can be effected.

N. C. & St. L. Ry. Keen Competition Key to Fuel Economy on N. C. & St. L. Ry., J. B. Hill. Ry. Rev., vol. 70, no. 20, May 20, 1922, pp. 701–705, 7 figs. Rivalry based on individual and divisional fuel performance records improves entire operation of railroad.

Wabash Railroad. How the Wabash Railroad is Organized for Fuel Economy, J. B. Hurley. Ry. Rev., vol. 70, no. 20, May 20, 1922, pp. 705–708. Practical supervision, individual performance records and monthly meetings result in large fuel saving.

FUELS

See AUTOMOBILE FUELS, COAL, COKE, GASOLINE, LIGNITE, OIL FUEL, PULVERIZED COAL.

FURNACES, BOILER

Air Preheaters. European Preheater for Furnace Air. Power, vol. 55, no. 16, Apr. 18, 1922, pp. 615–616, 3 figs. Describes type of air heater, known as Thermix, manufactured by Emile Prat-Daniel, Paris, which is said to be finding extensive employment in Europe.

FURNACES, ELECTRIC

See ELECTRIC FURNACES.

FURNACES, HOT-AIR

Developments. Recent Developments in Warm Air Furnace Heating, F. R. Still. Am. Soc. Heat. & Vent. Engrs., vol. 28, no. 4, May 1922, pp. 385–395, 5 figs. Valuable suggestions sponsored by Warm Air Furnace Code Committee, including formulas and charts and some facts about circulation stimulators.

FURNACES, METALLURGICAL

Low-Heat Gas-Fired. Furnaces Utilize Low Heat Gases, R. J. Weitlaner. Iron Trade Rev., vol. 70, no. 19, May 11, 1922, pp. 1332–1334, 6 figs. Application of split-flame principle and employment of regenerators similar to those used with open hearths enable German furnaces of recent design to operate efficiently on inferior grade fuels.

G

GAGES

Gage Blocks. Measurement of Primary Standards by the Interferometer Method. Machy. (Lond.), vol. 20, no. 503, May 18, 1922, pp. 189–193, 6 figs. Checking gage blocks by N. P. L. comparator; an extremely sensitive mechanical apparatus for testing accuracy of precision slip gages.

Gage-Block Comparator. Comparator for Checking Precision Gage-blocks, Franklin D. Jones. Machy. (N. Y.), vol. 28, no. 9, May 1922, pp. 689–693, 6 figs. Extremely sensitive mechanical apparatus, which has proved very effective at plant of Pratt & Whitney Co. for testing accuracy of precision gage blocks.

GAS

Low-Heat-Unit. Advantages of Low Heat Unit Gas, Edward L. Rieha. Gas Age-Rec., vol. 49, no. 21, May 27, 1922, pp. 651–654, 659 and 660. Relative advantages to gas company and consumer of lower-heat-unit gas. Paper written for Southern Gas Assn. Annual Mtg.

GASOLINE

Water in. Determination of Water in Gasoline as Received—Exposed to Atmosphere, to Humid Atmosphere, and Saturated with Water. Air Service Information Circular, vol. 4, no. 320, Mar. 15, 1922, 2 pp., 1 fig. Investigation to ascertain whether, sufficient amounts of water can be absorbed by gasoline to cause corrosion, and investigation of several methods for determining water in gasoline.

GEAR CUTTING

Hobbing Spur Gears. Cutting Spur Gears by Hobbing. Machy. (N. Y.), vol. 28, no. 9, May 1922, pp. 716–721, 5 figs. Setting up gear-hobbing machines; examples from practice; application of multiple-threaded hobs; cutting small pinions.

Internal Spur. Cutting Internal Spur Gears, F. D. Jones. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 776–779, 8 figs. Milling internal gear teeth with formed cutters; generating teeth on gear shaper; use of form-copying gear planer.

Mass Production. Mass Production in Gear-Cutting, Joseph Horner. Engineering, vol. 113, nos. 2935, 2937, 2938, Mar. 31, Apr. 14, Apr. 21, 1922, pp. 379–380, 443–445 and 477, 5 figs. Discusses methods associated with mass production of all kinds of gears, embracing such matters as division of operations between roughing and finishing, mounting of several blanks in series when practicable, and use of multiple cutters.

Spur. Cutting Spur Gears on Gear Planers. Machy. (Lond.), vol. 20, no. 502, May 11, 1922, pp. 153–162, 18 figs. Use of machines operating with planing action and forming gear teeth by generating from rack-shaped cutter. Sunderland system of gear generation.

Turbine Reduction Gears. Turbine Reduction Gearing and its Production, J. H. Melloy. Engineer, vol. 133, no. 3462, May 5, 1922, pp. 495–496, 3 figs. Means of attaining greatest accuracy in cutting, thereby obtaining silence, and smooth running. (Abstract) read before North-Western Section of Instn. Mech. Engrs.

GEARS

Bevel. The Assembling of Bevel Gears, Charles H. Logue. Am. Mach., vol. 56, no. 16, Apr. 20, 1922, pp. 580–584, 14 figs. Adjustment of pinion and of gear produce different results. Gears should be cut with allowance for backlash. Bottoming of teeth.

The Gleason System of Bevel Gears, F. W. McMullen and T. M. Durkan. Am. Mach., vol. 56, no. 23, June 8, 1922, pp. 849–853, 8 figs. Quietness in operation, strength and durability considered; limiting undercut; preference for low pressure angle; pressure causes wear.

The Gleason Works System of Bevel Gears, F. E. McMullen and T. M. Durkan. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 788–792, 8 figs. Description of Gleason improvement in design of form of tooth consistent with strength and wear.

New System of Bevel Gearing Developed by Recent Research, F. E. McMullen and T. M. Durkan. Automotive Industries, vol. 46, no. 20, May 18, 1922, pp. 1064–1068, 8 figs. Quietest form of tooth consistent with strength and durability. Addendum and dedendum for any pitch varies with ratio; usually different for pinion and gear. Pressure angle depends on number of teeth ratio. Paper read before Am. Gear Mfrs. Assn.

Chain. Chain Gearing. Machy. Market, no. 1124, May 19, 1922, pp. 23–25, 6 figs. Industrial applications. Facts about inverted-tooth type and larger sizes of roller chain and their uses.

Chattering. Nodal Arrangements of Geared Drives, J. H. Smith. Engineering, vol. 113, nos. 2936 and 2937, Apr. 7 and 14, 1922, pp. 438–440 and 467–469, 1 fig. Results of author's investigation of chattering of gearing. Deals with dynamics of geared drives; dynamically equivalent masses and shafts; equations of motion; effect of tooth-form irregularities. Results and general conclusions relating to critical speeds; simplification of geared drives; arranging periodicity of disturbing torques. Paper read before (British) Instn. Nav. Architects.

Comparator for Testing Teeth. Inspecting Gear and Gear Cutters at One Hundred Magnifications, Ralph E. Flanders. Iron Age, vol. 109, no. 17, Apr. 27, 1922, pp. 1137–1138 and 1183, 5 figs. Describes invention for use in connection with Hartness projection comparator for testing gear teeth. (Abstract.) Paper read before Am. Gear Mfrs.' Assn.

Helical. A Chart to Aid the Figuring of Helical Gears, W. C. Steuart. Am. Mach., vol. 56, no. 17, Apr. 27, 1922, pp. 630–633, 12 figs. Relation between elements of helical gears. Method of constructing "spiral" gear protractor. More rapid solution of problems in helical gearing.

Hot Rolling. The Hot Rolling of Gears, Reginald Trautschold. Forging & Heat Treating, vol. 8, no. 5, May 1922, pp. 216–219, 2 figs. Recent developments in and perfecting of process for successful production of gears by rolling blanks heated to forging temperature. Economy of process. See also Blast Furnace & Steel Plant, vol. 10, no. 5, May 1922, pp. 270–273, 2 figs.

Hydraulic Transmission. Recent Types of Hydraulic Transmission Gear. Eng. & Indus. Management, vol. 7, no. 11, Apr. 6, 1922, pp. 323–327, 5 figs. Discusses main requisites of efficient hydraulic gear and describes Williams-Janney, Hele-Shaw, and Constantinesco systems.

Machining. Tooling Equipment for Ball Races, Camshaft and Cluster Gears. Machy. (Lond.), vol. 20, no. 504, May 25, 1922, pp. 225–229, 14 figs. Examples of concentrated tooling.

Production, Estimating. Estimating Modern Gear Production, Gustave E. Spies. Am. Mach., vol. 56, no. 22, June 1, 1922, pp. 799–804, 7 figs. Charts and a slide rule that make estimating easy; use of disk cutters and hobs; extra travel of cutters; examples of estimate sheets.

Proportions. Proportions of Industrial Gears, G. E. Katzenmeyer. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 799–802, 4 figs. Formulas and tables which are used in developing standardized industrial gears.

Spur. Backlash in Hobber Spur Gears. Machy. (Lond.), vol. 20, no. 502, May 11, 1922, pp. 163–165, 5 figs. Amount of backlash recommended to provide for unavoidable inaccuracies in machining and heat-treatment.

Strength and Proportions. Strength and Proportion of Industrial Gears, G. E. Katzenmeyer. Am. Mach., vol. 56, no. 18, May 4, 1922, pp. 666–671, 7 figs. Charts for determining strength of industrial gears. Formulas and symbols used and practical examples.

Teeth, Grinding. Gear Tooth Grinding Process Reduces Heat Treatment Distortion Dangers, Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1162–1164, 3 figs. Finishing grinding gear teeth after heat treatment big factor in eliminating noise; permits resurfacing gears already finished cut to size and surfacing of gears which have grinding stock.

The Grinding of Gear Teeth and Its Future in the Industry, R. S. Drummond. Am. Mach. vol. 56, no. 21, May 25, 1922, pp. 779–781. Application of ground gear teeth in automotive industry; overcoming effects of heat treatment; elimination of noisy gearing by grinding. Paper read before Am. Gear Mfrs. Assn.

Testing, Optical. Testing Gear and Gear-Cutter Teeth, R. E. Flanders. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 817–819, 6 figs. Description of screw-thread comparator for quickly detecting imperfections. (Abstract.) Paper read before Am. Gear Mfrs. Assn. convention.

[See also REDUCTION GEARS.]

GRINDING

Automotive Engine Parts. Grinds Automotive Engine Parts, N. H. Westervelt. Abrasive Industry, vol. 3, no. 4, April 1922, pp. 99–103, 6 figs. Grinding machines are employed extensively for finishing cylindrical and plane surfaces accurately; careful inspection is necessary.

H

HANDLING MATERIALS

German Mechanical Devices. Development of Mechanical Handling Devices in Germany During and Since the War, George Frederick Zimmer. Eng. & Indus. Management, vol. 7, no. 11, Apr. 6, 1922, pp. 334–340, 13 figs. Deals with mechanical handling devices for blast furnaces.

Port Development, and. Material Handling in Its Relationship to Port Development. Engrs. & Eng., vol. 1, no. 3, Mar. 1922, pp. 65–77 and 96. Symposium of following articles: Design of a Port to Take Full Advantage of Mechanical Equipment, by Carroll R. Thompson; What Has Been Done and What We Should Plan to Do, by Fred Jasperson; What Can Be Done with Ship's Gear, S. C. Loveland. Discussion.

[See also ASH HANDLING, COAL HANDLING.]

HEAT

Conservation. Thermotechnical Control of Works (Wärmetechnische Überwachung der Betriebe), H. Strache. Elektrotechnik u. Maschinenbau, vol. 40, nos. 16 and 17, Apr. 16 and 23, 1922, pp. 184–187 and 198–201, 5 figs. Apr. 16: Discusses means for better utilization of fuels, including heat balance and efficiency of boilers, flue gases, CO_2 determination, etc. Apr. 23: Discusses various instruments for analyzing flue gases, draft gages, temperature measurement, selection of coal.

HEATING AND VENTILATING

Individual Units. Individual Heating and Ventilating Units, James Mackay. Domestic Eng. (Chicago), vol. 99, nos. 5 and 6, Apr. 29 and May 6, 1922, pp. 189–191 and 231–232, 11 figs. Notes on construction, installation and operation.

Research. Rietschel's Work and Its Continuation (Das Werk Rietschels und seine Fortführung), K. Brabbée. Gesundheits-Ingenieur, vol. 45, no. 16, Apr. 22, 1922, pp. 205–215, 25 figs. Reviews experimental work in heating and ventilating which was carried out by Rietschel and gives examples of results obtained.

HEATING, ELECTRIC

Industrial. Industrial Electric Heating for Factories, Wirt S. Scott. Elec. Jl., vol. 19, no. 5, May 1922, pp. 203–208, 8 figs. Pointing out the many possibilities as yet partially or entirely undeveloped.

HEATING, STEAM

Central Stations. Commission for the Utilization of Fuel—4th Report (Commission d'Utilisation du Combustible). Annales des Mines, vol. 1, no. 3, Mar. 1922, pp. 192–256. Gives report of First Sub-committee on actual practice at central steam heating stations, discussing their general character, types of boilers, superheating, economizers, air preheating, feedwater, etc.

HELICOPTERS

See AIRCRAFT, Power Requirements of.

HELIUM

Production. The Industrial Production of Helium, S. G. Roberts. Sci. Am., vol. 126, no. 5, May 1922, pp. 308–309, 5 figs. Improvements in past five years toward development of non-explosive airship.

HYDRAULIC MACHINERY

Rams. Hydraulic Rams, E. W. Anderson. Instn. Mech. Engrs. Proc., no. 2, 1922, pp. 337–355, 3 figs. Description of Anderson ram developed from experiments by author.

HYDRAULIC TURBINES

High-Speed Runners. Developments in High-Speed Runners for Hydraulic Turbines, Frank H. Rogers. Power, vol. 55, no. 17, Apr. 25, 1922, pp. 640–643, 8 figs. Limitations of Francis-type runners; comparison of different types of high-speed propeller runners; location of turbine with respect to tailwater; use of inverted-type and ejector-type turbines in low-head plants.

Mixed-Flow. The American Mixed-Flow Turbine and Its Setting, Arthur T. Safford and Edward Pierce Hamilton. Am. Soc. Civil Engrs. Proc., vol. 48, no. 4, Apr. 1922, pp. 753–808, 34 figs. Review of developments of turbine runner and of water-wheel setting.

Surge Tanks. Surge Tanks, B. F. Jakobsen. Am. Soc. Civil Engrs. Proc., vol. 48, no. 4, Apr. 1922, pp. 853–869, 15 figs. Distinction between surge-tank acceleration and deceleration and difference in requirements for medium-high head and high-head plants.

HYDROELECTRIC DEVELOPMENTS

Colorado River. Tentative Plan for the Construction of a 780-Foot Rock-Fill Dam, on the Colorado River, at Lee Ferry, Arizona, E. C. LaRue. Am. Soc. Civil Engrs. Proc., vol. 48, no. 4, Apr. 1922, pp. 835–852, 7 figs. Discusses practicability of constructing rock-fill dam in Colorado River; designed to raise water 700 ft. above river bed.

Colorado River Project. The World's Greatest Electrical Project, C. H. Peirson. Universal Engr., vol. 35, no. 5, May 1922, pp. 29–31. Plan to develop two and one-half million hp. of electric energy for power purposes.

HYDROELECTRIC PLANTS

Auxiliaries, Selection of. Selection of Auxiliaries for Hydro-Electric Power Stations, F. H. Rogers. Power, vol. 55, no. 20, May 16, 1922, pp. 775–777, 4 figs. Pumping statements for governor fluid. Lubrication statements for bearings. Small water wheels for auxiliary power.

Developments. Hydro-Electric Developments Involve an Expenditure of $150,000,000. Elec. World, vol. 79, no. 19, May 13, 1922, pp. 951–953, 2 figs. Construction in progress under licenses granted by Federal Power Commission involves almost 1,750,000 hp. Big Creek project largest for which license has been granted.

Kern River, California. Hydroelectric Installation on the Kern River, Ely C. Hutchinson. Universal Engr., vol. 35, no. 5, May 1922, pp. 23–26, 7 figs. Two turbo-generators arranged for dual operation at either 50 or 60 cycles; unique equipment for efficient use of water supply. (Abstract.) Paper presented at meeting of San Francisco Section of A.S.M.E.

New Brunswick. New Hydro Plant in New Brunswick. Contract Rec., vol. 63, no. 20, May 17, 1922, pp. 474–477, 5 figs. Unique installation just completed at Musquash River near St. John. Actually 2 plants in one. Work of New Brunswick Power Commission.

Smoky Falls, Ont. Smoky Falls Development on the Sturgeon River, C. C. Irvine. Can. Engr., vol. 42, no. 15, Apr. 11, 1922, pp. 377–379, 4 figs. Details of hydroelectric plant for Spanish River Pulp and Paper Mills at Smoky Falls, Ont. Present installation of 5200 hp. in two units with provision for two more units. Details of turbines and generators.

Western, Special Problems. Western Hydroelectric Development Meets Special Problems. Jl. Elec. West. Industry, vol. 48, no. 10, May 15, 1922, pp. 400–402. Western practice in meeting special conditions of water-power development on this coast analyzed in comprehensive report of hydraulic power committee of Pacific Coast electrical association.

I

IMPACT TESTING

Methods. A Discussion of Impact Testing Methods and the Results Obtained, John M. Lessells. Am. Soc. for Steel Treating Trans., vol. 2, no. 8, May 1922, pp. 659–672, 22 figs. Value of this method which shows up characteristics in heat-treated steel and not evident from conventional tests.

INDUSTRIAL MANAGEMENT

Bosses. Management that Includes Bosses in the Office and in the Shop, Frank E. Gooding. Elec. Rev. & Indus. Engr., vol. 80, no. 5, May 1922, pp. 260–261. Influence of industrial engineering on earnings of capital and labor. Conservation of materials, plant and equipment, and labor. Discussion at meeting of Soc. Indus. Eng.

British Factory. Scientific Management in the British Factory, Wm. J. Hiscox. Am. Mach., vol. 56, no. 23, June 8, 1922, pp. 837–838. Considered by some a revolutionary movement; why it cannot be adopted as a whole; methods not popular with organized labor.

Cost Recording and Production Control. Cost Recording and Production Control in Drop-Forging Plants H. F. Osler. Machy. (N. Y.) vol. 29, no. 10, June 1922, pp. 807–809, 3 figs. Description of system of management which has proven very successful in two drop-forging plants.

Divergence Charts. Divergence Charts and Their Uses, G. W. Greenwood. Management Eng., vol. 2, no. 6, June 1922, pp. 347–350, 4 figs. Means of presenting absolute differences between two magnitudes from month to month, and value of same.

File Factory, Organization of. The Organization of File Factories, H. G. Smith. Eng. & Indus. Management, vol. 7, no. 15, June 1, 1922, pp. 473–477. Development of organization from point when manufacturer orders raw material. Lecture before Sheffield File Trades Technical Soc.

Foundry Control. Co-ordinating Foundry Control, D. M. Avey. Iron Trade Rev., vol. 70, no. 22, June 1, 1922, pp. 1562–1566, 7 figs. How five large castings manufacturing plants solved problem of executive control involved through combining direction of general shop practice and research under one directing head.

Inspection Methods. Inspection Methods, E. Fairbrother. Eng. Production, vol. 4, no. 78, 79 and 80, Mar. 30, Apr. 6 and 13, 1922, pp. 303–306, 314–319 and 338–343, 35 figs. Development and practice. Notes on duties of an inspector; location of inspection department in factory. A system is described. Paper presented before Instn. Production Engrs.

Locomotive-Shop Schedules. Scheduling Operations in a Locomotive Repair Shop. Boiler Maker, vol. 22, no. 5, May 1922, pp. 121–125 and 138, 8 figs. Planning and routing repair operations and material; checking work as completed according to department schedules; eliminating delays by means of foremen check sheets.

Manager's Problems. Solving the Manager's Present Day Problems, John H. Van Deventer. Indus. Management, vol. 63, no. 6, June 1922, pp. 321–324. Fixity and flexibility as factors in organization.

Organization for Small Plant. A Workable Organization Plan for the Small-Plant Manager, M. B. Bartlett. Factory, vol. 28, no. 6, June 1922, pp. 640–643, 662 and 664, 3 figs. Practical system covering cost and purchase records, routine adaptable to most small plants.

Personnel Department, Duties of. Duties of a Personnel Department in an Industrial Plant, Bruce F. Brown. Jl. Elec. & West. Industry, vol. 48, no. 11, June 1, 1922, pp. 443–444. How one successful western industry has solved industrial problems among its workers by developing scope of its personnel department.

Production Planning. Planning with Equipment Standards, Chester D. Buoy. Indus. Management, vol. 63, no. 6, June 1922, pp. 363–365, 2 figs. Effective means of putting accurate and complete equipment standard data at service of planning department.

Production Regulation. Managing Production According to the Business Cycle, Ernest F. DuBrul. Management Eng., vol. 2, no. 6, June 1922, pp. 343–346, 1 fig. Fitting supply to demand in booms and depressions; analyzing business cycles.

Records, Equipment and Inspection. Equipment and Inspection Records. Elec. Rev. & Indus. Engr., vol. 80, no. 5, May 1922, pp. 211–213 and 216, 3 figs. Description of simple system which can be modified to suit large or small shop requirements.

Slow Sales. The Factory Cure for Slow Sales, E. L. Wayman. Factory, vol. 28, no. 6, June 1922, pp. 631–635, 2 figs. Investigation into production results in improvement in sales.

Stock Control. Flexible Stock Control at Lower Cost, H. J. Whitten. Factory, vol. 28, no. 5, May 1922, pp. 536–538 and 552, 3 figs. Notes on modern scientific store methods.

Works Organization. Works Organization—T. E. Pattinson. Eng. & Indus. Management, vol. 7, nos. 12, 13 and 14, Apr. 20, May 4 and 18, 1922, pp. 354–356, 388–391 and 430–431, 19 figs. Discusses ways of dealing with scrap and gives scrap charts. Machine-shop layout and operation. Paper read before Instn. Production Engrs.

INDUSTRIAL ORGANIZATION

Modern. Modern Industrial Organization, Hugo Hirst. Electrician, vol. 88, no. 2297, May 26, 1922, pp. 625–626. Some views gathered from 35 years' experience along this line. Based on address before Assn. Civil Servants.

INDUSTRIAL TRUCKS

Steam. Garrett Under-Type Steam Wagon. Engineer, vol. 133, no. 3458, Apr. 7, 1922, pp. 384–386, 13 figs. partly on supp. plate and p. 388. Features of interest of six-ton steam wagon are employment of pressed steel frame, double-chain drive, pedal speed regulator, and employment of Timken roller bearings.

INSULATION

Refrigerating Field. The Economic Thickness of Insulation in the Refrigerating Field, P. Nicholls. Am. Soc. Heating & Vent. Engrs. Jl., vol. 28, no. 3, Apr. 1922, pp. 343–358, 6 figs. Expense caused by leakage of heat, and formulas which include all definite expense factors. Consideration of case of walls of ice and cold-storage houses.

INTERNAL-COMBUSTION ENGINES

Hesselmans. A New Internal-Combustion Engine (En ny förbränningsmotor), E. Hubendick. Teknisk Tidskrift, vol. 52, no. 16, Apr. 22, 1922, pp. 259–266, 15 figs. Describes in detail the Hesselmans engine, its construction, and results of tests made with it.

[See also AIRPLANE ENGINES, AUTOMOBILE ENGINES, DIESEL ENGINES, OIL ENGINES, SEMI-DIESEL ENGINES.]

IRON

Spontaneous Ignition of Aluminum and. Spontaneous Ignition of Iron and Aluminum Chips (Die Selbstentzündung von Eisen- und Aluminiumspänen). Wärme- und Kälte-Technik, vol. 24, no. 8, Apr. 15, 1922, p. 97. Discusses the danger and recommends storage under water.

IRON INDUSTRY

Lorraine and Luxemburg. German Development of Iron Industries in Lorraine and Luxemburg to the End of 1918 (Stand des deutschen Ausbaues der lothringischen und luxemburgischen Eisenindustrie bis zum Jahre 1918), Walther Haug. Stahl u. Eisen, vol. 42, no. 19, May 11, 1922, pp. 728–734, 8 figs. Detailed description of development of blast-furnace works Karlshütte, Diedenhofen, and condition of works at end of 1918.

L

LADLES

Geared Design. Design Affects Ladle Operation, A. W. Gregg. Iron Trade Rev., vol. 70, no. 23, June 8, 1922, pp. 1648–1650, 4 figs. Different types of gearing have direct relation to ease in handling and safety; merits and disadvantages of worm, spur and helical worm gears; care of equipment emphasized. From paper read before Am. Foundrymen's Assn.

LATHES

Automatic. Milling Eight Transmission Covers At One Time, J. H. Moore. Can. Machy., vol. 27, no. 18, May 4, 1922, pp. 33–35, 8 figs. Describes automatic lathe designed for rapid production of duplicate parts in large quantities.

Turret. Saving Money by Means of the Turret Lathe, H. Alton. Can. Machy., vol. 27, no. 21, May 25, 1922, pp. 17–20, 10 figs. Production increased by efficient chucks and work-holding fixtures; indexing devices with ample wearing surface most suitable; machining hydraulic shock absorber; operations on bronze valve.

LIGHTHOUSES

Kerosene Lights. Developments in the Use of Paraffin for Coast Lighting. Engineering, vol. 113, no. 2940, May 5, 1922, pp. 541–544, 4 figs. Description of "Matthews," "Lux" and "Hood" burners; intensity of illumination and economy of each.

LIGHTING

Buildings. The Lighting of Public Buildings, A. L. Powell and Edgar Parker. Illuminating Eng. Soc. Trans., vol. 16, no. 9, Dec. 30, 1921, pp. 533–550, 13 figs. Lighting of art galleries, statuary, museums, libraries, municipal, county and state buildings, and banks. Bibliography.

Illumination Requirements for Workshops of Optical and Precision Instruments (Die lichttechnischen Anforderungen an die Beleuchtung von Optiker- und Feinmechaniker-Werkstätten) H. Lux. Deutsche Optische Wochenschrift, vol. 8, nos. 19 and 20, May 7 and 14, 1922, pp. 350–353 and 372–373, 1 fig. Discusses standards of German Illumination Soc. on general and local lighting, daylight and artificial lighting, etc.

Factory. Lighting the Factory, S. G. Hibben. Factory, vol. 28, no. 5, May 1922, pp. 523–526, 6 figs. Discusses harnessing daylight with refracting prisms, curtains and ground glass; and substituting for artificial light in whole or in part.

Industrial. Industrial Illumination. Eng. & Indus. Management, vol. 7, no. 14, May 18, 1922, pp. 450–451, 453, 455 and 457–460, 11 figs. Effect of good lighting on production; choice of lamps and fittings; correct light distribution; increasing workers' efficiency; economy in workshop.

Signs, Legibility. Factors that Determine Sign Legibility, C. A. Atherton. Elec. World, vol. 79, no. 21, May 27, 1922, pp. 1061–1064, 6 figs. Distance at which electrical announcements can be read may be diminished by brightness of lamps; atmospheric absorption compensates for brightness; mathematical relation of factors as determined by research.

Street. Highway Lighting, H. H. Ashinger. Elec. Jl., vol. 19, no. 5, May 1922, pp. 194–195, 2 figs. Design features of lighting units.

Improved Lighting System to Be Installed on Lincoln Highway, H. H. Bell. Elec. Wo ld, vol. 79, Apr. 15, 1922, pp. 731–732, 5 figs. Among features which it is intended shall mark completed work are concentration of light on roadway, flexibility of arrangement and reasonable cost of installation and maintenance.

The Value of Improved Street Lighting, C. H. Shepherd. Elec. Jl., vol. 19, no. 5, May 1922, pp. 187–190, 4 figs. Bringing out importance of proper street illumination and value to community

LIGNITE

Burning. Direct Drying of Brown Coal by Flue Gases and Firing the Dried Coal in Powder Form (Unmittelbare Trocknung der Rohbraunkohle mittels Feuergasen und Verheizung der getrockneten Kohle in Staubform), Max Weiss. Technische Blätter, vol. 12, No. 18, May 6, 1922, pp. 185–186, 3 figs. Describes installation of this kind in operation at Becker steel works at Willich.

LOCOMOTIVE BOILERS

Firebox Crown Stays. Stresses in the Firebox Crown Stays of Locomotive Boilers. Engineering, vol. 113, no. 2939, April 28, 1922, pp. 514–515, 4 figs. Staybolts directly connected to shell plating of cylindrical form as means of eliminating secondary stresses. Formulas and tables showing stresses.

LOCOMOTIVES

British and American. British and American Locomotive Design and Practice, P. C. Dewhurst. Engineer, vol. 133, no. 3456, Mar. 24, 1922, pp. 335–336. Comparison of systems. See also Ry. Gaz., vol. 36, no. 14, Apr. 7, 1922, pp. 593–596. (Abstract.) Paper read before Instn. Mech. Engrs.

British 4-6-2. 4-6-2 Type Passenger Locomotive for the Great Northern Railway. Engineering, vol. 113, no. 2937, Apr. 14, 1922, pp. 454–456, 6 figs. Engine has three cylinders, 20 in. by 26 in., and coupled wheels 80 in. in diam.; grate area, 41–25 sq. ft., coupled with firebox heating surface, 215 sq. ft. Boiler is of conical type, with front-ring barrel diam. of 69 in.

Construction. Locomotive Construction. Eng. Production, vol. 4, nos. 79 and 80, Apr. 6 and 13, 1922, pp. 321–327 and 347–351, 28 figs. Methods in Great Western Works at Swindon, England.

Design and Practice. British and American Locomotive Design and Practice, P. C. Dewhurst. Ry. Engr., vol. 43, no. 508, May 1922, pp. 169–172. Summary of paper read at recent meeting of Inst. of Mech. Engrs.

Decapod. Russian "Decapod" Locomotives, A. Lipetz. Ry. Engr., vol. 43, nos. 505 and 507, Feb. and Apr. 1922, pp. 51–54 and 136–137, 9 figs. Describes new 2-10-0 type locomotive built in America to conform with Russian Ministry of Railways specification.

4-Cylinder Compound Rack Type. Four-Cylinder Compound Rack Type Locomotives (C1+Z) at the Höllental Railroad in Baden (Die Vierzylinder-verbund-Reibungs- und -Zahnradlokomotiven (C1+Z) auf der badischen Höllentalbahn). Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 15, Apr. 15, 1922, pp. 361–366, 13 figs. Design; construction; equipment; performance; operation.

Power Transmission in. Power Transmission in Locomotives From the Engine to the Wheels (Di alcuni dei principali biellismi per trasmissione del movimento dai motori alle ruote nelle locomotive a motori rotanti), Andrea Caminati. Elettrotecnica, vol. 9, no. 10, Apr. 5, 1922, pp. 222–230, 19 figs. Principles of individual transmission, and for various combinations of wheels.

Tests. Results of Tests With Steam Locomotives (Versuchsergebnisse mit Dampflokomotiven), R. Sanzin. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 251, 1921, 37 pp., 28 figs. Describes tests carried out with special runs to determine maximum tractive power and gives particulars as to fuel, evaporation, etc.

Turbine, Application of. Application of the Turbine to Locomotive Practice. Can. Ry. & Mar. World, no. 292, June 1922, pp. 280–281. Various recent experiments in application of turbines to locomotives.

Turbine Type. Turbine Locomotive Saves 52 Per Cent in Fuel. Ry. Age, vol. 72, no. 22, June 3, 1922, pp. 1295–1296, 1 fig. Describes many novel features of design brought out by Ljungstrom Turbine Co. of Sweden.

Uniflow, Developments. Recent Developments in the Unaflow Locomotive. Ry. Mech. Engr., vol. 96, no. 5, May 1922, pp. 247–250, 7 figs. Exhaust ejector effect overcomes handicap of high compression and reduces size of cylinders.

LUBRICATING OILS

Viscosity. Influence of Viscosity on Operation of Oiling Systems, W. F. Osborne. Power, vol. 55, no. 21, May 23, 1922, pp. 820–821. Mechanical considerations where oil is to be used; effect of viscosity.

LUBRICATION

Filtering Methods. Modern Filtering Methods for Lubricating Systems, W. F. Osborne. Power, vol. 55, no. 24, June 13, 1922, pp. 930–931, 3 figs. Advantages and disadvantages of five general methods.

M

MACHINE TOOLS

Attachments. Attachments for Surfacing, Boring, and Drilling Machines. Engineer, vol. 133, no. 3458, Apr. 7, 1922, p. 395, 5 figs. Describes series of attachments now being made by H. W. Kearns & Co., Ltd., Broadheath, including vertical milling, flange-drilling and grinding attachments and dial traverse indicators.

Automatic. Automatic Machines Replace Hand Labor. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1057–1060, 8 figs. Element of human error eliminated and production costs reduced with special equipment at plant of Bock Bearing Co., Toledo.

Design. Methods of Machine Tool Design, A. L. DeLeeuw. Am. Mach., vol. 56, nos. 16 and 17, Apr. 20 and 27, 1922, pp. 577–579 and 617–620, 3 figs. Points out that usual machine-design methods do not always apply in designing machine tools. Apr. 20: Definition, classification and requirements of a machine tool. Apr. 27: Design of commercial and single-purpose machines contrasted. Shorthand symbols for designer.

Tool Engineering, Albert A. Dowd and Frank W. Curtis. Am. Mach. vol. 56, no. 19, May 11, 1922, pp. 702–705, 6 figs. Methods employed in designing tools for turret lathes. Use of layouts and

sketches; familiarity with machines necessary for designer.

Design Standards. Tool Design Standards, H. P. Losely. Machy. (N. Y.), vol. 28, no. 9, May, 1922, pp. 713–715, 2 figs. Development of standard instruction sheets for use of tool designers.

Railway Shops. Machine Tools in the Railway Shop. Eng. Production, vol. 4, nos. 76, 77, 78, 79, 80, 81, 82 and 83, Mar. 16, 23, 30, Apr. 6, 13, 20, 27 and May 4, 1922, pp. 244–248, 279–283, 293–297, 329–332, 352–357, 366–370, 398–403 and 427–432, 106 figs. Review of latest practice in machine-tool and other equipment designed for use in railway shops. Describes representative types of modern equipment.

MACHINE WORK

Optical Instruments, Use in. Use of Optical Instruments in Machine Work. Am. Mach., vol. 56, no. 19, May 11, 1922, pp. 697–701, 19 figs. Microscope and projector used to check location and contour of work. Accurate gear and rack cutting; an eyepiece with radial lines.

MAGNESIUM

Use in Foundry. Magnesium and Its Use in the Foundry (Le Magnésium et son utilisation en Fonderie), J. Gaillard. Fonderie Moderne, no. 1, Jan. 1922, pp. 17–21. Substitution of aluminum by magnesium, and chemical properties of latter; magnesium alloys; etc.

MAGNESIUM ALLOYS

Dowmetal. Dowmetal and Its Applications, J. A. Gann. Am. Soc. for Steel Treating Trans., vol. 2, no. 7, Apr. 1922, pp. 607–615 and (discussion) 615–619, 14 figs. Describes series of magnesium alloys produced by the Dow Chemical Co., commercially known as dowmetal. Characteristics and uses.

MARINE BOILERS

Economic Equipment and Operation. Possibilities of Further Economy in Marine Boilers, John Reid. Engineering, vol. 113, no. 2937, Apr. 14, 1922, pp. 472–475, 8 figs. Author suggests certain remedies for heat losses in Scotch boilers and indicates how they may be applied. Paper read before (British) Instn. Nav. Architects.

MATERIALS

Pressure Effect on Physical Properties. Change of the Physical Properties of Materials with Pressure, Erskine D. Williamson. Franklin Inst. Jl., vol. 193, no. 4, Apr. 1922, pp. 491–513, 8 figs. Tools employed in experiments. Change of electrical resistance with pressure; effect of pressure on thermo-electromotive force at junction of two metals; conductivity of solutions; effect of pressure on compressibility; and on viscosity of liquids.

MEASUREMENTS

Flattening of Measuring Bodies. The Validity of the Hertzian Formulas for the Calculation of the Flattening of Measuring Bodies (Ueber die Gultigkeit der Hertzschen Formeln zur Berechnung der Abplattung von Messkörpern), G. Berndt. Zeit. für technische Physik, vol. 3, nos. 1 and 3, 1922, pp. 14–21 and 69–78, 2 figs. Investigation of validity of Hertz's formulas for calculation of deformation of unlevel surfaces of measuring bodies.

MEASURING INSTRUMENTS

Selection and Use. The Selection and Use of Instruments in Industrial Plants, Frederick J. Schlink. Management Eng., vol. 2, no. 6, June 1922, pp. 337–342, 6 figs. Importance of care in selection and use, and suggestions.

METALS

Kinetic Theory and Thermal Energy. On the Kinetic Theory of Solids (Metals) and the Partition of Thermal Energy, B. M. Sen. Lond., Edinburgh, & Dublin Philosophical Mag., vol. 43, no. 256, Apr. 1922, pp. 672–687, 1 fig. Part I: Investigation of theory of solid state with rough working model of 14 molecules placed on sphere about each individual molecule at center. Part II: Restatement of theory for cubic and face-centered cubic crystals.

Mechanical Properties. On the Variation of Mechanical Properties of Some Metals and Alloys at Low Temperatures (Sur la variation des propriétés mécaniques de quelques métaux et alliages aux basses températures), Léon Guillet and Jean Cournot. Révue de Metallurgie, vol. 19, no. 4, Apr. 1922, pp. 215–221, 9 figs. Describes experiments with special steels, ferronickel, cobalt, copper alloys, and aluminum alloys, and gives results in tabular form.

MICA

Properties and Uses. Properties and Uses of Micas. Instn. Elec. Engrs. Jl., vol. 60, no. 307, Mar. 1922, pp. 339–342 and (discussion) 342–346. Notes on specifications, identification tests; selection mica and micanite for commutators; commutator segment separators; rings and cones. Report from British Elec. & Allied Industries Research Assn. See also India-Rubber Jl., vol. 63, no. 19, May 13, 1922, p. 16.

MONEL METAL

Arc-Welding, Metallic Deoxidizers. The Use of Metallic Deoxidizers in Arc-Welding with Monel Metal, P. D. Merica and J. G. Schoener. Am. Welding Soc. Jl., vol. 1, no. 5, May 1922, pp. 13–18, 6 figs. New method which has overcome difficulties of welding this metal. Welding properties of monel metal; preparation and composition of coating powder; some tests of arc welding.

MOTOR BOATS

French Navy, Coastal. Coastal Motor Boat for the French Navy. Engineering, vol. 113, no. 2940, May 5, 1922, pp. 548–551, 15 figs. Description of small high-speed torpedo vessels which are adopted as result of usefulness during war.

MOTOR BUSES

Garford and Fageol. New Designs Added to Growing List of Special Bus Chassis. Automotive Industries, vol. 46, no. 19, May 11, 1922, pp. 1003–1005, 4 figs. Underslung springs and worm permit use of lower body platforms, while kickup in frame gives necessary axle clearance. Wider tread gives more body space and greater stability. Unit powerplant used in Fageol stage.

Paris. A New Parisian Omnibus (Un nouvel Omnibus parisien), Jean Texier. Industrie des Tramways, vol. 16, no. 182, Feb. 1922, pp. 37–41, 6 figs. Details of construction of a three-axle motor bus having 48 seats with front and back wheels driven.

MOTOR TRUCKS

Construction, German. The Present Status of German Motor Truck Construction (Der Stand des deutschen Lastkraftwagenbaues), Erwin Aders. Zeit. des Vereines deutscher Ingenieure, vol. 66, nos. 16 and 17, Apr. 22 and May 6, 1922, pp. 387–391 and 443–447, 31 figs. Apr. 22: Discusses increased employment of motor trucks; improvements in construction, especially of engines; lubrication, atomizers, cooling, etc. May 6: Driving, braking, spring suspensions, etc.

Design. Motor Truck Design from the Truck Buyer's Viewpoint, Cornelius R. Myers. Indus. Management, vol. 63, no. 5, May 1922, pp. 273–281, 11 figs. Important features in buying transportation which might be overlooked in salesman's emphasis on detail.

Logging Methods. Motor Truck Logging Methods, Frederick Malcolm Knapp. Univ. of Wash. Eng. Exper. Station Bul., no. 12, Apr. 1921, pp. 3–29, 13 figs. Useful facts for ordinary truck type not including tractor and caterpillar.

Motors. Thermic Importance of Motors for Trucks (Thermische Vervollkommnung der Kraftwagen-Motoren), Heller. Archiv fur Warmewirtschaft, vol. 3, no. 4, Apr. 1922, pp. 67–70, 17 figs. Method of packing; limitation of heat transmission to walls; experiments with pistons of various alloys; play and wear of pistons; etc.

Producer-Gas-Fueled. Land Transport and the Gas Producer, R. J. Mitchell. Eng. Rev., vol. 35, no. 10, Apr. 1922, pp. 335–337, 1 fig. Description of gas producer developed by D. J. Smith applied to motor truck which shows marked economy over liquid-fueled type.

Straker-Squire. The 5-ton Straker-Squire Chassis, Automobile Engr., vol. 12, no. 163, May 1922, pp. 130–138, 18 figs. One of few entirely new British designs since war which abounds in original features; 58 hp. at 1100 r.p.m.

MOTORSHIPS

Diesel Machinery for Single-Screw. Diesel Machinery for Single-Screw Motor Ships, James Richardson. Engineering, vol. 113, no. 2936, Apr. 7, 1922, pp. 416–419, 8 figs.; also Shipbldg. & Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 471–475, 8 figs. Deals with problems inherent to single-screw Diesel machinery. Paper read before (British) Instn. Nav. Architects.

N

NON-FERROUS METALS

Gas Absorption and Oxidation. Gas Absorption and Oxidation of Non-ferrous Metals, B. Wyoski and J. W. Boeck. Trans. Amer. Inst. Min. & Met. Engrs., issued with Min. & Metallurgy, May 1922, no. 1160-N, 8 pp., 2 figs. Argument that oxidation and gassing of bronzes and red brasses can not take place simultaneously, and conditions effecting each.

O

OIL

Crude. Properties of Some Typical American Crude Oils. Oil Eng. & Finance, vol. 1, no. 19, May 29, 1922, pp. 613–616. Selected analyses from 33 Western oils and 39 from Eastern fields, carried out under auspices of U. S. Bur. Mines.

OIL ENGINES

Airless-Injection. New Airless-Injection System for Oil Engines, E. Lundgren. Motorship, vol. 7, no. 6, June 1922, pp. 444–445, 4 figs. Remarkable results obtained from highly scientific experiments made by Hesselman in Sweden.

Design and Operation. Oil Engine Hints. Power Plant Eng., vol. 26, no. 11, June 1, 1922, pp. 565–569, 5 figs. Proportions, installation of engine, operating suggestions for modern installation.

Foundations. An Erector's Experiences in Building Oil-Engine Foundations, L. H. Morrison. Power, vol. 55, no. 17, Apr. 25, 1922, pp. 651–654, 8 figs. Increasing use of this type of engine makes consideration of details of foundation design important.

OIL FUEL

Heavy Oils. Receiving Heavy Fuel Oils (Réception des combustibles liquides lourds). Bul. Technique du Bureau Veritas, vol. 3, nos. 11 and 12, Nov. and Dec. 1921 and vol. 4, no. 1, Jan. 1922, pp. 272–276, 293–295 and 8–13, 16 figs. Nov.: Calorific power and determination of quantity of sulphur. Dec.: Sampling on board ship with or without convenience of a laboratory. Jan.: Sampling of tanks, tank steamers, etc., and calculation of quantities taken aboard.

Receiving Heavy Liquid Fuels, Fuel Oils and Gas Oils (Reception des combustibles liquides lourds). Bul. Technique du Bureau Veritas, vol. 3, nos. 11 and 12, Nov. and Dec. 1921, pp. 272–276 and 293–295, 9 figs. Nov.: Distillation of oils and experience with various apparatus. Dec.: Testing on board ship with and without apparatus.

OPEN-HEARTH FURNACES

Design. Design of Open-Hearth Furnaces, A. D. Williams. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1075–1076. Consideration of port areas and velocities as affected by pressures; chimney height determined.

Fuel Utilization. Utilizing Fuels in Open Hearths, Herbert F. Miller, Jr. Iron Trade Rev., vol. 70, no. 23, June 8, 1922, pp. 1646–1647 and 1650, 6 figs. Present pressures of both air and gas in gas-fired furnaces are too low and should be increased from ounces to pounds; experiments show that time of heating may be reduced. From paper read before Am. Iron & Steel Inst.

Valve Design. Improving Reversing Valve Design, Wm. C. Bulmer. Iron Trade Rev., vol. 70, no. 22, June 1, 1922, pp. 1560–1561. Types of air or gas valve providing most effective seal and affording unrestricted passage is considered best for open hearths; water-cooled slide with inclined seat is favored.

OSCILLOGRAPHS

Turbo-Generator Investigation. Investigation of Oscillation Phenomena in Turbo-Generators. Untersuchung von Schwingungserscheinungen an Turbodynamos mit Hilfe des Vibrographen), Jos. Geiger. Zeit. des Vereines deutscher Ingenieure, vol. 66, no. 18, May 6, 1922, pp. 437–440, 39 figs. Explains investigation by means of vibrograph; methods of measuring used; successful methods adopted to eliminate vibration.

OXY-ACETYLENE CUTTING

Cutting Machines. Efficiency of Machine Cutting, F. J. Maeurer. Welding Engr., vol. 7, no. 5, May 1922, pp. 17–23, 25 figs. Cutting with oxy-acetylene torch can be made to approach very closely maximum theoretical efficiency. Paper read before Am. Welding Soc.

Underwater. Cutting Metals Under Water. Robert G. Skerrett. Compressed Air Mag., vol. 27, no. 5, May 1922, pp. 129–133, 14 figs. Repairing broken 36-in. diam. water main under New York Harbor by means of submarine torch and compressed air.

OXY-ACETYLENE WELDING

Water Main, Submarine. The Repair of The New York-Brooklyn Submarine Water Main. Engineering, vol. 113, no. 2939, April 28, 1922, pp. 509–511, 8 figs. Account of procedure and discussion of apparatus used.

P

PAINTS

Photometric Integrating Spheres, for. Paints for Integrating Spheres, A. H. Taylor. Illuminating Eng. Soc. Trans., vol. 16, no. 9, Dec. 30, 1921, pp. 587–590 and (discussion) pp. 599–605. Requirements of satisfactory paint. Preparation of zinc oxide paint now being used at Bur. of Standards.

PAPER MANUFACTURE

Power. Power Used in Papermaking, A. G. Darling and H. W. Rogers. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 20–24. Heat and mechanical energy must be balanced. Demands for steam in processes.

Water Wheels. Water Wheels in Making Groundwood, Adolph F. Meyer. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 58–66. Suggestions as to selection and regulation of speed of water wheels for grinding machinery. Paper read before Tech. Assn. of Pulp & Paper Industry.

PAPER MILLS

Electric Generation of Steam. Electric Generation of Steam, Horace Drever and Frank Hodson. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 73–75 and 78–81, 3 figs. Recent development in conversion of electric energy into steam by means of electric steam generator; underlying theories and practical application. Paper read before Technical Assn. of Pulp and Paper Industry.

Electricity in, Use of. Electricity in the Paper Mill, R. W. Leeper. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 24–28. Uses of the force from power plant to finished product.

Water-Power Sources, Canada. Mill Waterpower Sources in Canada. Paper, vol. 30, no. 7, Apr. 19, 1922, pp. 11–18, 8 figs. Paper prepared by Dominion Water Power Branch of Dept. of Interior, Ottawa, Ont., giving power supply of various mills in Canada.

PATENTS

Ownership, Employer and Employee. Relation of Employer and Employee as Regards Ownership of Patents, Maurice Block. Chem. Age (N. Y.), vol. 30, no. 5, May 1922, pp. 201–202. Discussion of rights of employer and employee in patents on inventions developed by an employee. Legal precedents.

PETROLEUM

Bibliography. Recent Articles on Petroleum and Allied Substances. U. S. Bur. of Mines Reports on Investigations, serial no. 2340, Mar. 1922, 29 pp. Bibliography compiled by E. H. Boroughs.

Federal Specification Revision. Federal Government Revises Petroleum Specifications. Automotive Industries, vol. 46, no. 19, May 11, 1922, pp. 1012–1013. 1 fig. Color test only change of importance in respect to motor gasoline. Points on distillation curve unchanged. Viscosity limits on lubricating oils are altered and some minor changes are made in other items.

PHOSPHOR BRONZE

Properties and Manufacture. Phosphor-Bronze from the Engineering Standpoint, R. T. Rolfe. Metal Industry, vol. 20, nos. 18 and 19, May 5 and 12, 1922, pp. 413–416 and 437–438, 3 figs. May 5: Classification, composition and tests. Manufacture, microstructure and bearing properties of 85:15. May 12: Alloys for gear wheels and characteristics. Manufacture and uses of malleable.

PHOTOELASTICITY

Application to Engineering Problems. Photo-Elasticity and Its Application to Engineering Problems, P. Heymans. Tech. Eng. News, vol. 3, no. 3, June 1922, pp. 80–85, 96, and 100, 27 figs. Application of temporary birefraction properties, shown by transparent bodies when stressed, on general stress determinations.

PIGMENTS

Titanium. Manufacture and Properties of Titanium White (Fabrication et propriétés du blanc de titane), Ch. Coffignier. Chimie & Industrie, vol. 7, no. 4, Apr. 1922, pp. 651–661, 11 figs. Manufacture and properties of white pigments in Norway, America and France; describes Devaux, Paquet and Andreu processes.

PIPE LINES

Capacity-Calculation Chart. A Linear Chart for Calculating Pipe Line Capacities, C. H. M. Burnham. Natural Gas Industry, vol. 16, no. 5, May 1922, p. 165. Graphic method of solving usual pipe-line capacity equation.

Superheated Steam. The Most Economic Pipe Diameter for Superheated Steam Lines (Der billigste Rohrdurchmesser fur Heissdampf-Kraftleitungen), O. Jenecke. Wärme, vol. 45, nos. 8, 9, 10 and 11, Feb. 24, Mar. 3, 10 and 17, 1922, pp. 104–105, 113–115, 125–128 and 136–139, 3 figs. Mathematical paper discussing pipe diameter for least steam loss on saturated-steam lines; most economic diameter for various loads of machines; increase of yearly operating costs by departing from most economic diameter; examples of practical calculations.

PIPES

Economic Size. Economic Size of Pipe for Power Purposes, George E. Lyon. Eng. & Contracting, vol. 57, no. 19, May 10, 1922, pp. 436–437, 1 fig. Formulas and curves from which proper diameters can be found.

PIPES, CAST-IRON

Flexible-Joint. Making 30-Inch Flexible Joint Cast-Iron Pipe, William G. Hammerstrom. Eng. News-Rec., vol. 88, no. 19, May 11, 1922, pp. 780–782, 5 figs. Spherical-shaped bell and spigot on each length machined to give flexibility at every joint; foundry practice.

PISTONS

Dowmetal. A Superior Piston Material. Motor Boating, vol. 29, no. 6, June 1922, pp. 39 and 100, 2 figs. Dowmetal, an alloy composed of high percentage of magnesium and small amounts of other metals, manufactured by Dow Chem. Co., Midland, Mich., for pistons of internal-combustion engines, equal, if not superior, to cast iron or aluminum.

Machining. Tooling Equipments for Pistons. Machy. (Lond.), vol. 20, no. 504, May 25, 1922, pp. 220–224, 13 figs. Use of automatic machines and special equipment for machining pistons at high rate of production.

POWER GENERATION

Rating of Supply Undertakings. The Rating of Electric Power Supply Undertakings, L. Andrews. Elec. Times, vol. 61, no. 1596, May 18, 1922, pp. 477–478, 1 fig. Economic consideration of various factors and necessity of analyzing same.

POWER PLANTS

Auxiliaries. Power Plant Auxiliaries, L. R. Lee. Power Plant Eng., vol. 26, no. 11, June 1, 1922, pp. 553–557, 4 figs. Requirements and types used in modern plants.

Auxiliaries Drive. Under What Conditions are Steam Turbines Preferable to Electrical Units for Driving Auxiliaries? Coal Age, vol. 21, no. 21, May 25, 1922, pp. 875–876, 1 fig. Turbines save conversion costs; independent steam units may release large generator at times of idleness; cheap fuel makes heat balance less imperative.

Calumet Station, Chicago. Calumet Station Power Plant Eng., vol. 26, no. 10, May 15, 1922, pp. 497–508, 17 figs. Description of Commonwealth Edison Company's new plant which will ultimately produce 180,000 kw.

Hell Gate. New Hell Gate Power Station. Power, vol. 55, no. 18, May 2, 1922, pp. 678–686, 12 figs. Description and table of principal equipment of this plant of United Elec. Light & Power Co.

The Hell Gate Station, Howard W. Leitch. Elec. Jl., vol. 19, no. 5, May 1922, pp. 214–220. 14 figs. Layouts, curves, illustrations and general description.

Maintaining Heat Balance at Hell Gate. Power, vol. 55, no. 20, May 16, 1922, pp. 760–763 4 figs. Features of units and control.

Switching Equipment for the Hell Gate Station, C. M. Moss and J. B. Macneill. Elec. Jl., vol. 19, no. 5, May 1922, pp. 221–226, 10 figs. Description of unusually good installation at this plant.

Lots Road Station, London. Lots Road Power Station, London "Underground" Railways. Ry. Gaz., vol. 36, no. 19, May 12, 1922, pp. 777–780, 3 figs. This station, opened in Feb. 1905, is largest in British Isles erected for supplying current for railway traction and associated purposes. New plant recently added is described, and main features of original equipment, in so far as it still applies, are set forth.

Producer-Gas. Some Observations on a Producer-Gas Power Plant, H. S. Denny and N. V. S. Knibbs. Instn. Mech. Engrs. Proc., no. 2, 1922, pp. 97–194, 17 figs. Thorough examination of use of coal with view to economy.

Sheboygan, Wis. New Plant of Badger State Tanning Co. Power Plant Eng., vol. 26, no. 11, June 1, 1922, pp. 547–553, 10 figs. Description of new installation of uniflow engines with a.c. individual motor drives.

POWER TRANSMISSION

Drive, Unit and Line. Comparative Advantages of Unit and Line Drive in Industry, H. P. Phillips. Jl. Elec. & West. Industry, vol. 48, no. 11, June 1, 1922, pp. 445–447, 6 figs. Discussion of mechanical installations in some important western industrial plants tending to show that adoption of unit or line drive depends upon type of work to be done.

Electric vs. Mechanical. The Merits of Electrical vs. Mechanical Power Transmission, R. Gillespie Williams. Eng. & Indus. Management, vol. 7, no. 11, Apr. 6, 1922, pp. 319–322, 3 figs. Deals with questions relating to running costs and maintenance, and economical arrangement of electric generator plant.

Fluid Waves. Transmitting Power in Fluid Waves. Sci. Am., vol. 126, no. 5, May 1922, pp. 320 and 362. Setting up wave motions or pulsations in enclosed column of liquid, usually water, which is contained in pipe connecting wave-generating apparatus with point of power application. Discusses generator now on market and applications.

Machinery. A Review of Power-Transmission Machinery. Belting, vol. 20, nos. 4 and 5, Apr. and May 1922, pp. 29–30 and pp. 36 and 38, 10 figs. Apr.: Deals with steel hangers. May: Steel pulleys and one type of steel hanger.

PRESSES

Accident Elimination. Eliminating Cold Trim Press Accidents, G. A. Kuechenmeister. Can. Machy., vol. 27, no. 21, May 25, 1922, pp. 21 and 29, 2 figs. Danger of working on unguarded presses; repeating of press ram not always cause of trouble; unsatisfactory experiments with mechanical tripping devices; electrical guard which has solved problem.

PULVERIZED COAL

Boiler Firing. Commission of Fuel Utilization—3rd Report (Commission d'Utilisation du Combustible). Annales des Mines, vol. 1, no. 2, Feb. 1922, pp. 99–152. Firing with pulverized coal. Actual developments in use of pulverized coal; description of installation using it; detailed description of advantages and drawbacks.

Firing With Pulverized Coal (Ueber Kohlenstaubfeuerungen), Max Birkner. Wärme, vol. 45, no. 16, Apr. 21, 1922, pp. 201–204, 3 figs. Storage of pulverized coal; pulverizing; economic limitation of size of powder; combustion chamber; some recent installations.

Powdered Coal. John Blizard. Colliery Guardian, vol. 123, nos. 3198, 3199 and 3201, Apr. 13, 21 and May 5, 1922, pp. 918–919, 990–991 and 1119–1120, 10 figs. Apr. 13: Functions of powdered-fuel plant; preparation and distribution of fuel. Apr. 21: Various appliances employed in use of pulverized fuel; applications of powdered fuel. May 5: Use of powdered fuel in raising of steam cost and inherent dangers involved. From Bul. Can. Dept. Mines.

Power Plants. First Large Plant Using Pulverized Coal Exclusively. Elec. World, vol. 79, no. 15, Apr. 15, 1922, pp. 720–724, 13 figs. partly on supp. plate. Lakeside generating station of Milwaukee Elec. Ry. & Light Co. designed for initial capacity of 40,000 kva., with ultimate rating of 200,000 kva. Central control and minimum of attendance. See also Power, vol. 55, no. 16, Apr. 18, 1922, pp. 604–610, 16 figs. partly on supp. plate; and Elec. Ry. Jl., vol. 59, no. 15, Apr. 15, 1922, pp. 633–640, 15 figs. partly on supp. plate.

PUMPING PLANTS

Hamilton, Ont. Beach Water Works Pumping Plant at Hamilton, R. De Bruno-Austin. Can. Engr., vol. 42, no. 19, May 9, 1922, pp. 462–468, 8 figs. General description of machinery, with special reference to recent installation of 2 ten-million-gallon pumping units; tests show efficiencies as high as 80 per cent; historical review of earlier equipment.

Maple Ridge, B. C. New Pumping Plant for the Maple Ridge Dyking in B. C., H. M. Burwell. Contract Rec., vol. 63, no. 20, May 17, 1922, pp. 465–467, 4 figs. Old pumps in service for 27 years for reclaiming 9,000 acres of rich land, replaced by two 20,000 g.p.m. electrically-driven centrifugal pumps. Unusual type of valves.

PUMPING STATIONS

Stand-By Service. A 2,500-Kva. Diesel-Engine Plant for Stand-by Service, Homer I. Steffa. Power, vol. 55, no. 21, May 23, 1922, pp. 804–809, 8 figs. Calumet station equipped with four 750-b.hp. two-stroke cycle Diesel-engine generator units, insuring breakdown service for sewage-pumping stations.

PYROMETERS

Optical. Disappearing Filament Pyrometer, Engineering, vol. 113, no. 2938, April 21, 1922, p. 501, 5 figs. Design and construction of optical pyrometer for industrial and laboratory work, made by H. Tinsley & Co.; improvement of this type of pyrometer by placing lamp in one arm of Wheatstone bridge.

R

RAILWAY ELECTRIFICATION

Austria. The Electrification of the Austrian Federal Railways and the Development of Austrian Water Power (Die Einführung der elektrischen Zugförderung auf den österreichischen Staatsbahnen und der Ausbau der österreichischen Wasserkräfte), R. Seifert. Zentralblatt der Bauverwaltung, vol. 42, nos. 21 and 22, Mar. 11 and 18, 1922, pp. 117–120 and 133–134, 4 figs. Discusses plans for electrification of 1788 km. of railway lines, of which 726 km. are double-track.

Chile. Electrification on the Chilean Railway. Ry. & Locomotive Eng., vol. 35, no. 5, May 1922, pp. 111–115, 6 figs. Solution of high cost of fuel, and congested traffic. Descriptions of locomotive equipment.

Gothard Line, Switzerland. Where Electrification Is Both Logical and Picturesque. Ry. Rev., vol. 70, no. 16, Apr. 22, 1922, pp. 559–564, 17 figs. Alpine water power being substituted for imported coal on famous Gothard line in Switzerland.

Industrial Plants. Yard Electrification of Industrial Plant Railways, D. M. Petty. Engrs. & Eng., vol. 1, no. 3, Mar. 1922 pp. 79–84 and 96–97. Underrunning third-rail scheme is best suited for heavy work and low voltages; existing substations used to supply d.c. power; etc.

Mountain Districts. Advantages of Electrical Operation in Mountain Districts, Frank Rusch. Gen. Elec. Rev., vol. 25, no. 6, June 1922, pp. 362–364. Some features of 660 route miles operation of C., M., & St. Paul Ry. Co., on five mountain ranges. (Reprinted from Milwaukee Employees Mag., Mar. 1922.)

Voltages Near Ground. Railway Electrification and Safety Limits of Voltages Near the Ground. Tramway & Ry. World, vol. 51, no. 24, May 18, 1922, pp. 243–244. Discussion of limits of voltage safety for third rail or near ground.

RAILWAY MANAGEMENT

Chinese Government. The Administration of Chinese Government Railways, Ching-Chun Wang. Assn. Chinese & Am. Engrs. Jl., vol. 3, no. 1, Jan. 1922, pp. 3–16, 2 figs. Development; statistical features; central administration; improvements.

RAILWAY MOTOR CARS

Diesel-Electric. Diesel-Electric Motor Cars for Railway Service. Ry. Age, vol. 72, no. 20, May 20, 1922, pp. 1183–1184, 2 figs. Successful operation in Sweden has led to introduction of 250-hp. cars.

Gasoline. Developments in Bus-Type Rail Cars for Local Service. Ry. Rev., vol. 70, no. 18, May 6, 1922, pp. 633–635, 5 figs. Describes rail cars with both Mack and White Company chassis.

Some Recent Developments in Gasoline Motor Rail Cars, W. L. Bean. Ry. Rev., vol. 70, no. 21, May 27, 1922, pp. 741–747, 8 figs. Present equipment admirable in design but limited in capacity; railways need larger cars built on same principle.

The Power Behind the Modern Gasoline Motor Rail Car. Ry. Rev., vol. 70, no. 19, May 13, 1922, pp. 669–673, 6 figs. Features to which consideration must be given in selection of power unit for gasoline rail-car operation. Describes Midwest heavy-duty high-speed engine.

Type Selection. Railcars are Needed—But What Type? Herbert Chase. Automotive Industries, vol. 46, no. 22, June 1, 1922, pp. 1150–1152, 6 figs. Consideration of factors entering into selection of type.

RAILWAY OPERATION

Amphibious. By Rail and By Water. Sci. Am., vol. 126, no. 6, June 1922, p. 374, 5 figs. Combination train and two barges invented by Belgian engineer for use in Congo.

Parallel Traffic Working. "Parallel" Traffic Working on South Eastern & Chatham Railway. Ry. Gaz., vol. 36, no. 20, May 19, 1922, pp. 805–814, 7 figs. By systematic scheduling of trains on "Parallel" basis in both directions, time-keeping is improved, facilities increased, signaling movements reduced, and engines and rolling-stock utilized to better advantage.

Suburban Passenger Service. The Operation of Heavy Suburban Passenger Services on A Steam Railway, F. V. Russell. Ry. Gaz., vol. 36, no. 21, May 26, 1922, pp. 841–842. Steam and electric traction compared. Suggestions for adoption by steam railways of features in use in electrically-operated ones. From Lecture before Roy. Soc. Arts.

Train Control. Automatic Train Control Systems Ry. Elec. Engr., vol. 13, no. 4, Apr. 1922, pp. 117–126, 21 figs. Four articles, describing the Regan contact shoe and ramp type, the Simmen speed control system, the Wooding and the Miller systems.

Freight Train Tests of Train Control on the C. I. & W. R. R. Ry. Rev., vol. 70, no. 18, May 6, 1922, pp. 627–628, 1 fig. Particulars of test designed to show action of Shadle system of train control in operation of heavy freight train.

Shadle Automatic Train Signal-Stop. Ry. Elec. Engr., vol. 13, no. 5, May 1922, pp. 149–150, 3 figs. Intermittent ramp contact type incorporating cab signals and speed control which have been developed on C. I. & W.

The American Train Control System. Ry. Elec. Engr., vol. 13, no. 5, May 1922, pp. 156–159, 6 figs. Developed on Maryland and Pennsylvania railroad and brought before Interstate Commerce Commission in 1907. Installed on C. & O.; inspected by Railroad Administration in 1919. Intermittent contact type.

The Sprague System of Automatic Train Control. Ry. Rev., vol. 70, no. 21, May 27, 1922, pp. 747–757, 11 figs. Description of test installation in electric zone of New York Central R.R.

RAILWAY SHOPS

Management. Improvements in Workshop Management (Verbesserungen im Werkstättenbetrieb), Hans A. Martens. Verkehrstechnik, special number, May 1922, pp. 240–247, 1 fig. Discusses methods in use on German state railways and proposes improvements for more efficient control.

Tools and Fixtures. Special Tools and Fixtures in a Southern Railroad Shop, S. Ashton Hand. Am. Mach., vol. 56, no. 17, Apr. 27, 1922, pp. 613–616, 15 figs. Describes equipment of shops of Chesapeake & Ohio Ry., Richmond, Va.

RAILWAY SIGNALING

Alsace-Lorraine. Signaling on the Alsace-Lorraine Railways (Dispositions adoptées pour assurer la sécurité des trains sur le réseau d'Alsace-Lorraine), Georges Levi. Annales des Mines, vol. 1, no. 4, Apr. 1922, pp. 266–315, 10 figs. Describes in detail principles and operation of signaling system in force to assure safety of trains.

Interlocking. New Interlocking on the C. R. R. of N. J., Fred W. Bender. Ry. Signal Engr., vol. 15, no. 5, May 1922, pp. 184–189, 14 figs. Large electro-pneumatic plant at Phillipsburg, N. J., uses new operating mechanisms and lead-covered cables.

Location of Signals. Location of Signals as an Aid to Traffic Working, R. S. Proud. Engineering, vol. 113, no. 2939, April 28, 1922, pp. 533–535, 3 figs. Signals from standpoint of traffic handling rather than safety. Paper read before Instn. Ry. Signal Engrs.

RAILWAY TERMINALS

Electrification. Operation of an Electrified Terminal, L. E. Lynde. Elec. Traction, vol. 28, no. 5, May 1922, pp. 403–404, 2 figs. Conditions at Broad Street Station, Philadelphia, as compared with steam operation on this portion of Penna. system.

RAILWAY TIES

Electric Resistance. Electrical Resistance of Treated and Untreated Crossties, P. R. Hicks. Ry. Signal Engr., vol. 15, no. 5, May 1922, pp. 190–192, 2 figs. Results of measurements made by Forest Prod. Laboratory in coöperation with Chicago, Milwaukee & St. Paul.

RAILWAY TRACK

Machines for Track Work. Special Machines and Combinations for Track Work. Eng. & Contracting, vol. 57, no. 16, Apr. 19, 1922, pp. 368–370, 3 figs. Information on use of mechanical appliances and tools in track work and organization of labor involved, given in appendix to report presented before Am. Ry. Eng. Assn. by Committee on Rules and Organization. (Abstract.)

RAILWAYS

Australia and China. Railway Problems in Australia and China, T. R. Johnson. Inst. of Transport Jl., vol. 3, no. 4, May 1922, pp. 214–222 and (discussion) 222–225. Some facts about rail transportation in these two countries.

REDUCTION GEARS

Double. Double Reduction Gears in the SS. "Melmore Head," J. W. Wilkie. Engineering, vol. 113, no. 2937, Apr. 14, 1922, pp. 469–471, 6 figs. Detailed account of troubles experienced with double-reduction gearing, together with description of methods recently adopted to overcome them. [Paper read at Spring Mtg. of I. N. A.] See also Mar. Engr. & Naval Archt., vol. 45, no. 536, May 1922, p. 190 and Shipbldg. & Shipg. Rec., vol. 19, no. 15, Apr. 13, 1922, pp. 457–460.

Turbine. Turbine Reduction Gearing and Its Production, J. H. Melloy. Mar. Engr. & Naval Architect, vol. 45, no. 536, May 1922, pp. 184–187, 3 figs. Hobbing process with particular reference to Muir & Melloy patent hobbing machine. Abstract of paper read before Northwestern Branch of I.M.E.

REFRIGERANTS

Hydrocarbon. Some Properties of Hydro-Carbon Refrigerants, H. D. Edwards. A.S.R.E. Jl., vol. 8, no. 6, May 1922, pp. 488–495, 5 figs. Discusses use of butane, propane, ethane, and makes comparison with ammonia.

REFRIGERATING MACHINES

Compression. Effect of Water Cooling Jackets on Compression Refrigerating Machines (Der Einfluss des Kühlwassermantels an Kompressions-Kältemaschinen), Walther Fischer. Forschungsarbeiten auf dem Gebiete des Ingenieurwesens, no. 244, 1921, 78 pp., 25 figs. Investigation into the advantage of water-cooling jacket on cylinder of compressor for refrigerating machines of various types.

REFRIGERATING PLANTS

Steam vs. Electric Drive. A Few Facts About Steam- and Electric-Driven Refrigerating Plants, G. E. Porce. Power, vol. 55, no. 22, May 30, 1922, pp. 855–856. Comparison of electric motors and other prime movers.

Testing Rules for. Rules for Efficiency Testing of Refrigerating Machines and Plants (Regeln für Leistungsversuche an Kältemaschinen und Kühlanlagen). Zeit. für die gesamte Kälte-Industrie, vol. 29, no. 4, Apr. 1922, pp. 57–68, 6 figs. Gives rules formulated by the German Refrigerating Soc. and also the Standard Committee of the German Industry.

REFRIGERATION

Insulation, Thickness of. The Economic Thickness of Insulation in the Refrigerating Field, P. Nicholls. Am. Soc. Heat. & Vent. Engrs. Jl., vol. 28, no. 3, Apr. 1922, pp. 343–358, 6 figs. Various items of monetary expense which leakage of heat causes and formulas which include all of the definite expense factors.

Low-Temperature. Recent Developments in Low-Temperature Work (Neuere Entwicklung der Tieftemperaturtechnik), F. Pollitzer. Zeit. für die gesamte Kälte-Industrie, vol. 28, no. 9, Sept. 1921, pp. 125–133, 12 figs. Discusses large increase in expenditure of energy to reach temperatures lower than that of liquid air; describes Borsigwalde oxygen works and their equipment.

RIVERS

Canalization of St. Lawrence. An Examination of the Plan for Canalizing the St. Lawrence River, Wilfred H. Schoff. Engrs. & Eng., vol. 1, no. 3, Mar. 1922, pp. 85–89. Author concludes that as economical investment in combined power and navigation it is not desirable. Better to develop each separately.

Colorado. Controlling the Principal Artery of the Southwest States, C. E. Grunsky. Jl. Elec. & West. Industry, vol. 48, no. 9, May 1, 1922, pp. 348–350, 4 figs. Discusses feasibility of construction of dam that would rise to height of 550 ft., storing 25,000,000 acre-ft. of water which will irrigate thousands of acres of arid land, protect Imperial Valley from disastrous floods and generate approximately 600,000 hp. of electrical energy.

The Colorado River; Its Control and Development. Eng. News-Rec., vol. 88, no. 18, May 4, 1922, pp. 741–744, 2 figs. Hydraulics of river and demand for power, flood control and irrigation subject of federal report. Recommendations include Boulder Canyon dam and all-American canal in Imperial Valley.

ROADS

Truck Overloading. Analysis of Connecticut's Traffic Census Data Yields Facts on Truck Overloading, J. Gordon McKay. Eng. News-Rec., vol. 88, no. 20, May 18, 1922, pp. 826–830, 5 figs. Digest of report made for U. S. Bur. of Public Roads shows every third truck to be loaded beyond capacity of truck and tires.

ROLLING MILLS

Cold-Rolling Strip. New Five-Stand Cold-Rolling Strip Mill. Iron Age, vol. 109, no. 19, May 11, 1922, pp. 1289–1291, 5 figs. Tandem mill of new design has unusual flexibility of control; electric power a feature.

Continuous. Development of Continuous Rolling Mills, John W. Sheperdson. Iron Age, vol. 109, nos. 11, 15 and 17, Mar. 23, Apr. 13 and 27, 1922, pp. 791–794, 993–995 and 1149–1151, 15 figs. Design affected by fundamental conditions, specific problems, and co-relation of units. Merchant mills not well adapted to continuous principle. Selection of cooling-bed length; staggering of mills. Paper read before Engrs'. Soc. West. Pa.

Electrification Progress. Mill Electrification Progresses, Wilfred Sykes. Iron Trade Rev., vol. 70, no. 22, June 1, 1922, pp. 1550–1554, 1 fig. Recent years have witnessed number of large installations of motor drives on rolling mills; operation results are satisfactory; power and motor size not limited; general plant layout discussed. From paper read before Am. Iron & Steel Inst.

Hot Billet Scraper. An Automatic Hot Billet Scraper, R. C. Rohrabacher. Iron Age, vol. 109, no. 17, Apr. 27, 1922, pp. 1126–1128, 6 figs. Mechanical device for removing defects in use in Canadian rolling mill. Advantages and savings.

Strip Mills. New Continuous Ten-Stand Strip Mill. Iron Age, vol. 109, no. 22, June 1, 1922, pp. 1510–1512, 3 figs. Compact unit which was designed for heavy production; interesting details given of electric drive; arrangement at Trumbull Steel Co.

Wrought-Iron Bars, Rolling. Power Required to Roll Wrought Iron Bars, Edwin L. Fletcher. Iron Age, vol. 109, no. 17, Apr. 27, 1922, p. 1144. Results of tests that were made in reducing 3-in. billets to 1/2-in. rounds.

Zinc Sheet. Zinc Sheet Rolling Mills (Das Zinkblechwalzwerk), W. Krämer. Metall., no. 6, Mar. 25, 1922, pp. 67–71, 5 figs. Gives list of mills supplying zinc. Describes operations of the various passes which are similar to that of iron sheets.

ROPE

Flexible Steel. Making and Care of Flexible Steel Ropes, W. Voigtlander. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1065–1066, 1 fig. Operation of stranding machines; securing open ends of rope; effective strength with some wires broken.

Making and Care of Flexible Steel Ropes, W. Voigtlander. Eng. & Indus. Management, vol. 7, no. 15, June 1, 1922, pp. 463–465. Description of three steps in manufacture, lubrication and inspection when in use. Based on paper read before Assn. Iron & Steel Elec. Engrs.

S

SAFETY

Electricity in Factories. Electricity and Safety First in Factories, W. H. Seal. Electrician, vol. 88, no. 2297, May 26, 1922, pp. 618–623, 4 figs. Suggests code of safety rules; precautions desirable in using electrical machinery.

SAWS

Wire, for Slate and Marble. Wire Saws for Slate and Marble Cutting. Quarry, vol. 27, no. 303, May 1922, pp. 181–183, 4 figs. Description of this kind of saw used in England and abroad.

SCRAP

Railroad, Reclaiming of. Reclaiming a Railroad Scrap Pile, Edward K. Hammond. Machy. (N. Y.), vol. 28, no. 10, June 1922, pp. 769–772, 8 figs. Conversion into useful articles of much material found in scrap piles. How Can. Pacific turns ts scrap pile into source of revenue.

SCREW THREADS

Inspection by Optical Projection. Speeding Up Screw Thread Inspection by Optical Projection, Ralph E. Flanders. Automotive Industries, vol. 46, no. 21, May 25, 1922, pp. 1116–1119, 7 figs. Speed and accuracy attained by Hartness screw-thread comparator. Method applied to test cutters and to locate imperfect edges of gear teeth by tracing outline of median tooth section. Paper presented before Am. Gear Mfrs. Assn.

SCREWS

Machine Bolts and. Designing Machine Screws and Bolts, L. T. Rutledge. Can. Machy., vol. 27, nos. 8 and 10, Feb. 23 and Mar. 9, 1922, pp. 26–27 and 24–25 and 29, 6 figs. Feb. 23: Various thread shapes and their respective uses; screw thread as a power medium; thrust factor depending on shape; safety of bolts; pipe threads. Mar. 9: Screw threads for bolts and nuts. Bending stresses; stripping of threads; failure due to shear; lacking devices; effect of vibration; etc.

Milling. The Milling of Screws, H. H. Jeffcott. Engineering, vol. 113, no. 2936, Apr. 7, 1922, pp. 441–442, 5 figs. Account of problems of interest to manufacturer and metrologist. Paper read before (British) Instn. Mech. Engrs.

SEMI-DIESEL ENGINES

Operation. Semi-Diesel Engines (Les Moteurs Semi-Diesel). Technique Moderne, vol. 14, no. 4, Apr. 1922, pp. 145–150, 31 figs. Construction and operation, fuel injection, regulation and general application.

Water Injection in. The Use of Water Injection in Semi-Diesel Oil Engines, R. B. White. Power, vol. 55, no. 16, Apr. 18, 1922, pp. 617–618. Author claims that while water injection is necessary in low-pressure engines, it is not desirable and may be avoided by higher compressions; and that water does free cylinder of carbon, and its occasional use is recommended, even in dry engines.

SEWER CONSTRUCTION

Pneumatic Diggers. Pneumatic Clay Diggers Speed Sewer Tunnel Work, R. A. Lundell. Compressed Air Mag., vol. 27, no. 6, June 1922, pp. 167–168, 3 figs. Development of air-driven clay diggers eliminating picking or blasting, makes possible record progress in tunnel driving.

SHEARS

Hydroelectric Bloom. Hydro-Electric Bloom Shear. Iron Age, vol. 109, no. 16, Apr. 20, 1922, pp. 1078–1079, 4 figs. New method of operation devised for use in mills without steam power.

SHIP PROPULSION

Hydraulic Transmission. The Foettinger Hydraulic Transmission Gear of the Mail Boat "Tirpitz" (Les transformateurs hydrodynamiques "Foettinger" du paquebot "Tirpitz"), Grison. Bul. Technique du Bureau Veritas, vol. 4, no. 1, Jan. 1922, pp. 1–5, 6 figs. Built by Vulcan Shipyards for Hamburg-American Line. Design, operation, and tests of these gears which show efficiency of 90 per cent.

SNOW REMOVAL

Crane Cars. Crane Cars Solve Snow-Removal Problem. Elec. Ry. Jl., vol. 59, no. 20, May 20, 1922, pp. 825–827, 5 figs. Three crane cars designed by Third Ave. Ry., New York City, for general track repair and handling and transportation of miscellaneous materials have been used to increase snow-fighting equipment by addition of wings.

SPRINGS

Automobile. See AUTOMOBILES, Suspension.

Leaf, Modern Manufacture. Modern Methods of Making Leaf Springs, E. F. Lake. Iron Age, vol. 109, no. 20, May 18, 1922, pp. 1343–1346, 6 figs. Mechanical forming machines; tempering furnaces; assembling, testing and inspecting.

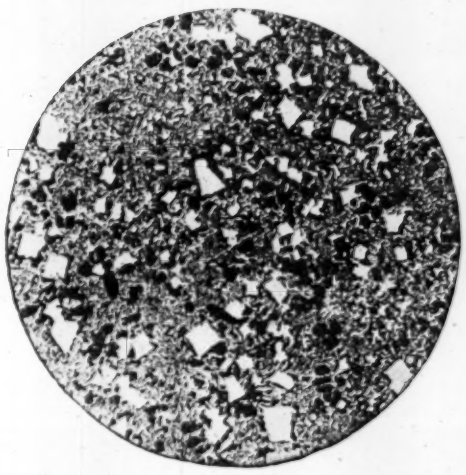
STANDARDS

British, Rail Testing Machines. Falling Weight Testing Machines for Rails. British Eng. Standards Assn., Apr. 1922, no. 103, 1 p.

U. S. Bureau of Standards. What the Bureau of Standards Can Do for You. Factory, vol. 28, no. 5, May 1922, pp. 540–541 and 554, 556 and 558, 3 figs. Indicates scope of service.

STEAM

Consumption, Calculation. Steam Consumption



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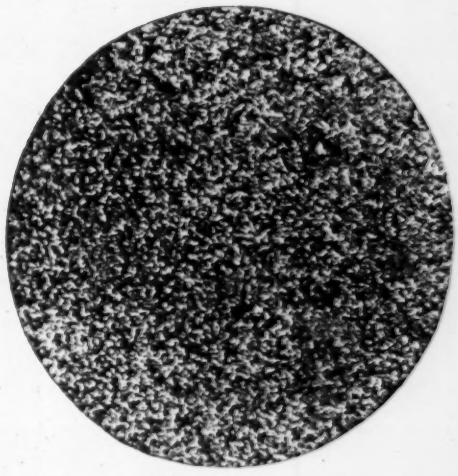

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